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2. *Chemistry* : Recent Work on the Higher Coal-tar Hydrocarbons.
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Dr. S. S. Bhatnagar	
Dr. J. N. Mukherjee	
Dr. P. C. Mitter	
Mr. P. R. Ray	} Past Recorder who is a Permanent Member.
Dr. P. Neogi	
Prof. H. B. Dunncliff	
Dr. P. C. Guha	

3. Geology—

Dr. M. S. Krishnan	Convener.
Dr. S. K. Roy	Recorder.
Prof. L. Rama Rao	} Elected Members.
Dr. A. S. Kalapesi	
Dr. L. L. Fermor	
Mr. D. N. Wadia	} Past Presidents who are Permanent Members.
Dr. B. Sahni	
Mr. P. Evans	
Prof. K. K. Mathur	
Mr. N. N. Chatterji	} Past Recorder who is a Permanent Member.

4. Botany—

Dr. J. H. Mitter	Convener.
Dr. S. R. Bose	Recorder.
Prof. Saieeduddin	} Elected Members.
Mr. K. P. Biswas	
Mr. C. C. Calder	} Past Presidents who are Permanent Members.
Rai Bahadur S. R. Kashyap (since deceased)			

Dr. B. Sahni	
Dr. S. P. Agharkar	
Rev. Dr. E. Blatter (since deceased)	
Dr. K. C. Mehta	} <i>Past Presidents who are Permanent Members.</i>
Prof. P. Parija	
Dr. T. Ekambaram	
Dr. H. Chaudhuri	
Dr. S. L. Ghose	
Prof. R. H. Dastur	
Dr. S. K. Mukerjee (since deceased)	} <i>Past Recorder who is a Permanent Member.</i>

5. Zoology—

Diwan Anand Kumar	Convener.
Dr. G. S. Thapar	Recorder.
Dr. B. K. Das	} <i>Elected Members.</i>
Dr. S. B. Setna	
Dr. F. H. Gravely	
Dr. K. N. Bahl	
Dr. B. Prashad	
Lt.-Col. R. B. S. Sewell	} <i>Past Presidents who are Permanent Members.</i>
Dr. B. Sundara Raj	
Dr. S. L. Hora	
Prof. B. L. Bhatia	
Dr. D. R. Bhattacharya	
Prof. R. Gopala Aiyar	
Prof. P. R. Awati	} <i>Past Recorders who are Permanent Members.</i>
Dr. H. Srinivasa Rao	
Dr. H. K. Mookerjee	
Dr. H. N. Ray	

6. Anthropology—

Dr. G. S. Ghurye	Convener.
Mr. T. C. Das	Recorder.
Dr. M. H. Krishnan	} <i>Elected Members.</i>
Mr. T. C. Roy Chaudhuri	
Prof. P. C. Mahalanobis	
Dr. J. H. Hutton	} <i>Past Presidents who are Permanent Members.</i>
Dr. B. S. Guha	
Lt.-Col. R. B. S. Sewell	
Rev. P. O. Bodding	
Mr. K. P. Chattopadhyay	
Dr. P. Mitra	
Rai Bahadur R. P. Chanda	} <i>Past Recorder who is a Permanent Member.</i>
Mr. H. C. Chakladar	

7. Agriculture—

Dr. F. J. F. Shaw	Convener.
Dr. S. V. Desai	Recorder.
Mr. K. Ramiah	} <i>Elected Members.</i>
Mr. J. C. Luthra	
Rao Bahadur M. R. Ramaswami Sivan	
Mr. B. C. Burt	} <i>Past Presidents who are Permanent Members.</i>
Rao Bahadur T. S. Venkataraman	
Sir T. Vijayaraghavacharya	
Mr. G. N. Rangaswami Ayyangar	
Mr. M. Afzal Husain	
Dr. S. S. Nehru	
Mr. N. V. Joshi	} <i>Past Recorder who is a Permanent Member.</i>

8. Medical and Veterinary Research—

Major K. R. K. Iyengar	<i>Convener.</i>
Dr. A. C. Ukil	<i>Recorder.</i>
Capt. S. Datta	} <i>Elected Members.</i>
Major S. L. Bhatia	
Sir S. R. Christophers	} <i>Past Presidents who are</i>
Sir U. N. Brahmachari	
Lt.-Col. A. D. Stewart	
Lt.-Col. S. S. Sokhey	} <i>Permanent Members.</i>
Dr. M. B. Soparkar	
		..	} <i>Past Recorder who is a</i>
		..	
		..	} <i>Permanent Member.</i>

9. Psychology—

Dr. S. C. Mitra	<i>Convener.</i>
Miss S. Ghosh	<i>Recorder.</i>
Mr. R. P. Kar	} <i>Elected Members.</i>
Mr. J. M. Sen	
Mr. N. S. N. Sastry	} <i>Past Presidents who are</i>
Mr. M. N. Banerji	
		..	} <i>Permanent Members.</i>

General.

The twenty-second meeting of the Indian Science Congress Association was held at Calcutta from January 2nd to 8th, 1935.

The inaugural meeting was held on Wednesday, January 2nd, 1935, at 10-30 A.M. in the Senate House, Calcutta University, in the presence of the Patrons His Excellency the Right Honourable Earl of Willingdon, G.M.S.I., G.M.I.E., G.C.M.G., G.B.E., Viceroy and Governor General of India, and His Excellency the Right Honourable Sir John Anderson, P.C., G.C.B., G.C.I.E., Governor of Bengal. Mr. S. P. Mukherjee, M.A., B.L., Bar.-at-Law, M.L.C., Chairman of the Local Reception Committee, and Vice-Chancellor of the Calcutta University, welcomed the delegates in a speech, and requested His Excellency the Viceroy to open the Congress. His Excellency opened the Congress with a speech, and then the President of the Congress, Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.A.S.B., I.C.S., delivered his address.

THE SECTIONAL PRESIDENTIAL ADDRESSES WERE DELIVERED AS FOLLOWS :—

THURSDAY, *3rd January*, 10 A.M., Botany; 11 A.M., Agriculture; 12 NOON, Medical and Veterinary Research.

FRIDAY, *4th January*, 10 A.M., Geology; 11 A.M., Chemistry; 12 NOON, Anthropology.

SATURDAY, *5th January*, 10 A.M., Mathematics and Physics; 11 A.M., Zoology; 12 NOON, Psychology.

SYMPOSIA AND JOINT MEETINGS OF SECTIONS WERE HELD AS FOLLOWS :—

THURSDAY, *3rd January*, 10 A.M., Discussion on the standardization of Courses in Zoology for the University Examinations. 12 NOON, Joint Meeting of the Sections of Agriculture, Chemistry, Botany, Geology, Mathematics and Physics, and Zoology to consider the report of the Committee appointed at the last session of the Congress relating to the foundation of an Indian Society of Soil Science.

FRIDAY, *4th January*, 11 A.M., Joint Meeting of the Sections of Botany and Agriculture to discuss the problem of Cereal Rusts in India. Symposium on 'The North Bihar Earthquake, 1934', Sections of Mathematics and Physics and Geology.

SATURDAY, 5th January, 11 A.M., Symposium on 'Chemical aspects of light absorption'. 12 NOON, Joint Meeting of the Sections of Botany and Zoology to discuss the Teaching of Elementary Biology in Secondary Schools in India.

MONDAY, 7th January, 10 A.M., Symposium on Cellulose Chemistry. 12 NOON, Symposium on Vitamins, Sections of Chemistry and Medical and Veterinary Research.

THE POPULAR LECTURES WERE DELIVERED AS FOLLOWS :—

THURSDAY, 3rd January, 6-30 P.M., 'The Structure of the Nucleus and the Transmutation of Elements', by Prof. B. Venkatesachar, Bangalore.

FRIDAY, 4th January, 6-30 P.M., 'The Quest for Oil', by P. Evans, Esq., Digboi.

SATURDAY, 5th January, 6 P.M., 'Chemistry and the Customs Duty', by Prof. H. B. Dunncliff, Lahore.

THE FOLLOWING FUNCTIONS AND ENTERTAINMENTS WERE HELD IN HONOUR OF THE MEMBERS OF THE INDIAN SCIENCE CONGRESS :—

WEDNESDAY, 2nd January, 2-30 P.M.-5-30 P.M., River Trip on the Hoogly. Local Reception Committee 'At Home' on board the steamer.

THURSDAY, 3rd January, 4 P.M., 'Garden Party' at Government House. 9 P.M., 'Musical Soiree' arranged by the Local Committee.

FRIDAY, 4th January, 4-30 P.M., The Mayor of Calcutta 'At Home' at Town Hall.

SATURDAY, 5th January, 4-30 P.M., The University of Calcutta 'At Home' at University College of Science, 92, Upper Circular Road.

MONDAY, 7th January, 2 P.M., Bengal Chemical and Pharmaceutical Works 'At Home'. 8 P.M., Science Congress Banquet, Grand Hotel.

THE FOLLOWING VISITS AND EXCURSIONS WERE ARRANGED FOR MEMBERS OF THE INDIAN SCIENCE CONGRESS :—

THURSDAY, 3rd January, 2 P.M.-4 P.M. :—

- (1) Indian State Broad-Casting Station and Studio.
- (2) Royal Botanic Gardens.
- (3) Bengal Engineering College.
- (4) Basanti Cotton Mills.
- (5) Dr. S. C. Law's Aviary.
- (6) Bengal Tanning Institute and Research Laboratory.
- (7) Asiatic Society of Bengal.
- (8) Indian Museum.

FRIDAY, 4th January, 2 P.M.-4-30 P.M. :—

- (1) Victoria Memorial.
- (2) St. Xavier's College.
- (3) Meteorological Observatory.
- (4) King George's Dock.
- (5) Zoological Gardens.
- (6) Government Telegraph Workshop and Telegraph and Telephone Laboratories.
- (7) Agartala Jute Mills.
- (8) Messrs. B. K. Paul and Co. Ltd.
- (9) All India Institute of Hygiene and Public Health.
- (10) School of Tropical Medicine.
- (11) Medical College (Teaching Department).
- (12) Medical College Hospitals.

SATURDAY, 5th January, 2 P.M.-4 P.M. :—

- (1) Dakshineswar.
- (2) Belur Math.
- (3) Radha Film Company.
- (4) Imperial Library.
- (5) Statesman Press.
- (6) Indian Association for Cultivation of Science.
- (7) Bose Institute.
- (8) Bengal Flying Club.
- (9) Bengal Immunity.

SUNDAY EXCURSIONS, 6th January :—

- (1) Jamshedpur : Tata Iron and Steel Company's Works.
- (2) Paharpur : Archaeological excavations.
- (3) Bolepur : Visvabharati of Dr. Rabindranath Tagore.
- (4) Gosaba : Sir Daniel Hamilton's model farm.
- (5) Rajmahal Hills : Fossil plants.

MONDAY, 7th January, 2 P.M.-4-30 P.M. :—

Bengal Chemical and Pharmaceutical Works, Ltd.

TUESDAY, 8th January, 2 P.M.-5 P.M. :—

- (1) Pulta Pumping Station and Tallah Reservoir.
- (2) University College of Science (Botany and Zoology Departments).

THE SECTIONAL COMMITTEES met at 12-45 P.M. on the 2nd January, 1935.

The COUNCIL met at 6 P.M. on the 2nd January, 1935.

The EXECUTIVE COMMITTEE met at 7-30 P.M. on the 2nd January, and at 2 P.M. on the 4th January, 1935.

The GENERAL COMMITTEE met at 2 P.M. on the 3rd January, and at 2 P.M. on the 5th January, 1935.

Opening Proceedings.

The twenty-second session of the Indian Science Congress was opened on Wednesday, January 2nd, 1935, at 10-30 A.M. by His Excellency the Viceroy, in the presence of His Excellency the Governor of Bengal and a large gathering of delegates and visitors. The Chairman of the Local Reception Committee, Mr. S. P. Mukherjee, welcomed His Excellency the Viceroy in a speech as follows :—

‘ YOUR EXCELLENCIES, PRESIDENT, LADIES AND GENTLEMEN,

On behalf of the Local Reception Committee and the University of Calcutta, it is my pleasant duty to extend to you all, to the members and to our distinguished President, a most cordial welcome to this city, the birth-place of the Indian Science Congress. It is our unique privilege to have in our midst to-day both Your Excellencies the Viceroy and the Governor and for this generous mark of appreciation we convey to you our deep and grateful thanks.

This is the fourth occasion that Calcutta has been chosen as the seat of the Congress. In spite of inevitable changes which a great city such as ours must witness with the passage of years, I believe you will find yourselves not in the midst of strange environments but in familiar surroundings, reminiscent of former associations of friendliness and comradeship.

During the last twenty-five years India has made noteworthy progress in the domain of higher scientific study and research. On an occasion like this we cannot but recall with pride and pleasure that this has been achieved mainly through the efforts of Indian scholars who, after assimilating the best that their own Universities could bestow, travelled abroad, equipped themselves with new knowledge and experience and came back to their motherland, trained for national service. In this great movement Calcutta has played her part with far-seeing vision and courage and has produced a band of capable and enthusiastic workers, who have by no means remained confined to their own University,—scholars whose contributions in the different branches of science have elicited the admiration of eminent scientists in other and distant parts of the world. The splendid work which the Calcutta University has been fortunate enough to accomplish has been possible as much on account of the far-sighted policy initiated by Sir Asutosh Mookerjee, your first President, as through the munificence of two of our illustrious countrymen, Sir Taraknath Palit and Sir Rashbehary Ghose, and later of the Kumar of Khaira. Outside the University the two institutions which have added most to Calcutta's fame and prestige are the Bose Institute and the Indian Association for the Cultivation of Science. Much valuable work has also been

done in the several scientific departments under State control which have been adorned by officers renowned for their ability and attainments. If Calcutta was the pioneer, other provinces have not lagged behind and the presence here of this distinguished galaxy of talent from all parts of India bears ample testimony to the progress which has been already achieved.

It will however be unwise for us to assume that we have reached our goal or have even come near it. Indeed much more remains to be done if India is to contribute her legitimate share to the scientific knowledge of the world. It is not for me to discuss here in detail the form your future activities should take. But, if you will permit me, I shall mention for your consideration only two problems of outstanding importance which must be solved if we are to enhance our national efficiency and prosperity.

It has been said that the future of civilization depends upon the widening spread and deepening hold of the scientific habit of mind and it becomes an urgent duty with you, who represent science in this ancient land of ours, to think out and promulgate practical methods for effecting this. It is for you to indicate how to develop "that questioning, impartial, problem-solving attitude of mind, which must obtain if truth and sanity are to rule the world". It should be as much your duty thus to contribute towards the making of the Indian Citizen as your privilege to closely relate science to our everyday life, to regard it not as the special field of work for the gifted few but to make it the inheritance of the many. Poets are often said to be the guides of mankind in the realm of thought, for they give shape and form to men's ideas. The same is no less true of men of science, with this difference that, while poets may draw inspiration from the limitless fountain of imagination, science, though not without its romance, cannot deviate from accuracy and truth. It is for you to raise the standard of education; to enrich its quality by interpreting the manifold discoveries of science to the lay public in non-technical language, preferably through our vernaculars; to unfold how the secrets of Nature have been brought to light; how resolutely darkness has been chased away, how science, like sunshine before mist, has cleared away doubt and superstition and opened up a never-ending vista before despairing humanity. This is one of the problems to which I venture to draw your attention.

The other is concerned with the possibility—nay the imperative necessity—of an increasingly closer connection between the institutions you represent and the development of Indian industries. While it is true that by your original researches you have attained individual eminence, and some have acquired international reputation, inspiring others to follow your examples, it is time for you to consider what contributions you can make for the industrial regeneration of your country, for the proper utilization of the inexhaustible raw materials in which India

abounds and which are at present being but partially utilized and that also not always to India's best advantage. Modern India asks you, have you considered the problem of helping the cause of your national progress not from the political platform where differences of opinion are bound to exist but from your quiet and peaceful laboratories and from your organized workshops? Have you considered how science should be applied towards the alleviation of poverty and sufferings of millions of your countrymen? It is for you to undertake a systematic and scientific investigation of India's industrial problems, the solution of which would result in the improvement of our economic condition. Who are better fitted for this great work than you, who are expected to act inspired solely by the lofty motive of serving your country and humanity and not for personal gain or profit? What nobler return can you give for all the facilities which you have been privileged to enjoy and for the confidence which your countrymen have reposed in you?

Your responsibilities are indeed immense. You have taken upon yourselves the sacred task of widening the boundaries of knowledge. Your contributions are subjected to searching examination by the master minds of other countries which offer opportunities to their scholars on a scale which we have yet to attain. On you rests the maintenance of India's prestige and reputation as a home for scientific and technological study and research. You cannot remain satisfied with academic achievements only. India expects you to utilize your attainments in such a way as to benefit your country and humanity at large—to regard science not as a powerful instrument of destruction but as a vital factor for promotion of the good of mankind. To enable you to fulfil this noble mission, you are justly entitled to unstinted assistance from the people and from Government. As trustees of the precious heritage of knowledge, may you use your gifts in a manner which may not at any stage be marred by petty jealousies or unprofitable friction; may you extend the usefulness of your organization from more to more, cementing all differences and raising higher and higher the mighty fabric of the Temple of Truth and Service whose doors will be thrown open to all seekers of knowledge, irrespective of caste, creed or colour!

In requesting Your Excellency to open the Congress it is my fervent wish that it may continue to receive your benevolent sympathy and support which will be no small asset in its onward march towards expansion and progress.'

His Excellency the Viceroy, as Patron of the Congress, then addressed the meeting as follows :—

'YOUR EXCELLENCY, DR. HUTTON, LADIES AND GENTLEMEN,

This is the fourth occasion upon which the Indian Science Congress has met in Calcutta. The first was the inaugural

meeting held in 1914 in the rooms of the Asiatic Society of Bengal. It met again in Calcutta in 1921, by which date the activities of the Congress had outgrown the capacity of the rooms of the Asiatic Society; and also in 1928. After the lapse of seven years, it reassembles in the great city of its birth. This is a well-deserved tribute to the intellectual and scientific attractions of Calcutta; but the very periodicity of these sessions in one centre, however eminent, illustrates the importance which the Congress attaches to maintaining touch with the length and breadth of India. Thus it is that you have visited in turn Madras, Bombay, Bangalore, Lahore, Lucknow, Allahabad, Patna and Nagpur. This is in the fitness of things. It is apt to be forgotten that India is a Sub-Continent, with many centres of vigorous and expanding intellectual life. A body, which confines its activities to any one place, can never achieve that synthesis of national service which must be the aim of, as indeed it is the sole justification for, an all-India organization.

Though your activities thus extend throughout India and though they indubitably exercise a wide-spread and an expanding influence, the Viceroy has never yet been present at one of your meetings. My distinguished predecessor, Lord Irwin, was unfortunately prevented by illness from being present in 1928. I am glad that, in this respect, I have been able to establish a precedent; I am confident that my friend and joint Patron of this session of the Congress, His Excellency Sir John Anderson, will not grudge me the pleasure (which would otherwise have fallen to him) of opening the present session and of affording a practical demonstration of the keen interest which I and my Government take in your deliberations.

I am even more glad that my presence here to-day coincides with what may be termed the 'coming of age' of the Congress. Ladies and Gentlemen, historical generalizations run the risk of giving an imperfect expression of the truth. Truth has many facets, and the greater the brevity of a generalization, the greater may be its imperfection; but I suggest that I run the least risk of this imperfection in describing our present age as predominantly the age of science. Every aspect of human activity bears testimony to this contention. Even literature has been enriched by the concepts and terminology of science. Economics and industry depend, for progress, on its quickening force. Human life has been shorn of many terrors of disease by the light which scientific investigation has thrown on their causes and on the methods of their prevention and cure. The data of science have provided new and fascinating material for those brilliant minds whose speculations seek the inner meaning of the nature of life and the universe.

India, the birth-place of philosophy, cannot but aspire to an active and honourable share in these movements, whether utilitarian or philosophic. But, as I have already suggested,

India is a land of vast distances, and the isolation of scientific workers presents a grave disadvantage; it is therefore, at least something that, once a year, leaders in science have been enabled to meet together in order to exchange experiences and also to examine and discuss the several contributions which have been made by scientists in India to the common stock of scientific knowledge. I offer my sincere good wishes not only for the successful deliberations of the present session, but also for the future development of your Association which, having completed twenty-one years of fruitful activity, now 'comes of age'. In the days that lie before us, India will need, more than ever before, your help and guidance.

It may be asked what part does Government play or propose to play in India's contribution to science. Members of the Congress will need no elaborate reminder of what the Government of India have done and are doing in this respect. Three Scientific Services, whose work has won world-wide recognition, owe their inception and existence to their initiative. I refer to the Geological, the Meteorological and the Zoological Surveys of India. Further, the Medical Research Department of the Government of India and the Indian Research Fund Association, which is financed by them, have done much to alleviate human suffering in combating those fell diseases which are still so powerful and so destructive. In the promotion of agricultural research, on which the prosperity of our agricultural masses so vitally depends, they still take a useful share through the agency of the Imperial Council of Agricultural Research. The problems of India's forests, a great economic asset, also receive attention in the laboratories of the Forest Research Institute, Dehra Dun. Again, a Bureau of Industrial Information and Research is in the process of formation; and only last month a Congress of Road Engineers met to devise ways and means of organizing research in problems of road construction. In modern times, a country without maps is a 'dark continent'. The preparation of such maps has been accepted in India for many years past as an important function of Government; the topographical maps of this country, which the Survey of India produce, bear comparison with those of any other country.

This enumeration of the Central Government's activities has not been made in any spirit of self-congratulation; it is intended merely to indicate that I and my Government have not been unaware of the benefits which should be derived from scientific research. I hasten to add that we shall continue to render assistance in these directions to such extent as our resources permit. Nor is my account in any sense exhaustive of the share of the State in scientific research. Under our present constitutional structure, responsibility for many branches of scientific activity, as, for example, in medicine, industry and agriculture, rests, within their own territorial limits, with

Provincial Governments. I have not touched upon their achievements owing to limitations of time as well as of information.

But, Ladies and Gentlemen, Government can be only a single factor in what is a nation-wide undertaking. Scientific research demands the sympathetic interest and the effective support of all who have India's welfare at heart ; of Governments, central and provincial ; of universities, which must remain the principal homes of fundamental research ; of pioneers of industrial development ; of landed magnates ; and last, but not least, of scientists themselves. Those private individuals or organizations whom fortune has favoured with command of material resources, can afford the much needed augmentation to the financial assistance rendered by the State and by universities. The example of the late Sir Jamsetji Tata, of the late Sir Tarak Nath Palit, and of the late Sir Rash Behari Ghose should be an emulous stimulant to private benefactors. Only then can universities and leaders of science satisfactorily enrich the stream of scientific work that flows from various centres of scientific activity.

I have viewed with special interest and appreciation the growing contact between scientific research and the practical demands and requirements of industry, of which the liberal assistance given by the Burma Oil Company towards the foundation of the College of Engineering in Rangoon, and the recent donation of Messrs. Steel Brothers for research in oil technology at Lahore are outstanding examples—examples which are also significant of a growing and beneficial contact between universities and industry, and which, I earnestly hope, are but the forerunners of a far closer intimacy between these two in the realm of scientific research. As for scientists themselves, besides directing the efforts of others, they can, by team work in the broadest sense of the word, ensure the maximum of achievement that is possible within available resources. For, however great may be the future assistance given by Government and by private benefactors, it can never be sufficient to satisfy the ever-increasing demands of scientific research. I would suggest, therefore, that there is urgent need for an effective and an economical husbanding of your resources. A well-devised co-ordination of scientific activities has become imperative ; it is from this standpoint that I especially welcome the functions and outlook of your Association.

Members of the Congress, I shall not detain you longer. I have greatly appreciated the privilege of inaugurating your proceedings. I shall now leave you to the more exacting part of your programme ; I am confident that, under the guidance of your distinguished President, Dr. Hutton, whose anthropological researches have made his name familiar wherever this interesting and valuable science is studied, your deliberations will be fruitful to the cause you serve.'

After the opening of the Congress, the President, Dr. J. H. Hutton, delivered his Presidential Address.

At the conclusion of the address, Dr. S. K. Mitra moved a vote of thanks to His Excellency the Viceroy, and to His Excellency the Governor of Bengal, for having attended the opening of the Congress.

Presidential Address.

Congress President :—J. H. HUTTON, C.I.E., M.A., D.Sc.,
F.A.S.B., I.C.S.

Presidential Address.

ANTHROPOLOGY AND INDIA.

YOUR EXCELLENCIES, LADIES, AND GENTLEMEN,

My first duty is the pleasant one of welcoming you here to-day and of thanking the Indian Science Congress for the distinction conferred on me by its invitation to preside over its activities at this its twenty-second meeting. When I accepted that invitation, not I confess without some compunction, I had not foreseen that this meeting would have the honour of being opened by H.E. the Viceroy, and was likely to be of additional importance as inaugurating the constitution of a National Institute, or Academy, of Sciences for India. I need not recapitulate that part of the address of the distinguished physicist, your twenty-first President, which explained and justified the proposal for a National Academy of Sciences put before you by him a year ago. It is enough to remind you that the Indian Science Congress marked its coming of age by appointing a committee to draft proposals for the institution of a body which should perform for India some of those functions which the Royal Society discharges with regard to science in the United Kingdom. These proposals, in accordance with your instructions, are to be laid before your General Committee at this session. The committee which you appointed through your General Committee was to be constituted of the following persons :—the outgoing and incoming Presidents of this Congress, seven representatives of nine scientific societies, eight representatives of nine scientific departments of Government, the Director or other representative of the Indian Science Institution, Bangalore, one representative of the Editorial Board of *Current Science*, Bangalore, and five members representing the General Committee of your Congress. This committee was given power to co-opt other members and did in fact so co-opt five representatives of five scientific societies and institutions and seven distinguished scientists in their personal capacity. The societies and individuals comprising this committee were drawn from nineteen different places in all parts of India, from the eight major provinces (exclusive of Burma) and from three of the major Indian States, while the members representing the scientific

departments of Government were mainly Europeans whose duties took them to all parts of India and who are strictly representative of none. Obviously a committee so composed could rarely, if ever, meet in full, and the General Committee of the 1934 Congress must have realized that when appointing it; nevertheless the meetings held were representative of five provinces, and of the 15 members who prepared the original draft for the rules and objects of the National Society to be created, four were representatives of your association, five of various learned societies, six of scientific departments of Government. Further, this committee had at its disposal the materials collected by the Editorial Board of *Current Science*, which had issued a questionnaire to obtain the opinions of Indian scientists on the formation of the proposed Academy, and the majority of the scientists who expressed their views on the subject approved 'of the idea of seeking State aid to start an entirely new organization which would be run more or less along the lines of the Royal Society of London, the details of the constitution, as also the process of initiation of the Academy, to be decided by a committee to be appointed for the purpose'. Such a committee you had appointed with instructions to take the necessary steps to bring the Academy into existence and to draft a constitution to be submitted for the approval of your General Committee at this Congress. The nature of the institution to be thus brought into existence was broadly indicated in a resolution of your General Committee. Seven meetings of the Academy Committee were held, at the first of which it was decided to determine in advance the number of Foundation Fellows to form the Academy and then to consider its constitution, as it was clearly desirable to have the constitution of the Academy approved by those, who were to form it, before the draft was submitted to the Indian Science Congress. Arrangements were therefore made for the allotment of fellowships to the various sciences and for the selection of the persons to fill them. It was decided that the question of the location of the Academy's headquarters must be postponed for the decision of the Foundation Fellows, and part of the set of rules drafted by Professor Meghnad Saha was also considered. Before the second meeting could take place, however, the work of the Academy Committee, as revealed in the copy of the minutes sent to absent members, was adversely criticized by Sir C. V. Raman, himself one of those members, in a presidential address to a conference of South Indian scientists at Bangalore. This was followed by his taking the unexpected step of registering a society as the 'Indian Academy of Sciences' at Bangalore, thus involving your Academy Committee in a sort of comic imbroglio more suited to the dignities of the two Kings (or was it mayors?) of Brentford than to those of the scientists of India. Your Academy Committee, however, went on with its work and ultimately came to an agreement with

the Bangalore Academy, the terms of which involved the substitution of the name 'National Institute of Sciences of India' for 'National Academy of Sciences of India', and some minor verbal changes in the draft of the aims and objects of the proposed body. The Indian Academy of Sciences, Bangalore, has in its turn made certain necessary changes in its memorandum of association and constitution, and the present position is that the body brought into existence by the Indian Science Congress will co-operate with the three existing bodies of Academy status in different parts of India and with such other academies of sufficient status as may be formed in the future.

Your Academy Committee have carried out their work under extremely difficult circumstances, and I would recommend you to accept, if you possibly can, the recommendations put forward with the report which they are presenting to you and which contains a full account of all that is necessary to your General Committee in reaching a decision. In coming to such a decision your General Committee will no doubt have the advantage of not being composed entirely of scientists. The institution of an Academy is not an act that demands of itself any specialized scientific knowledge. It is true that the scientific method of approach may be of no little value in forming a judgement on any problem; at the same time we have, as scientists, to beware of valuing ourselves and one another too highly, and of supposing that because a man knows very much about one subject he is therefore the more fitted to express an opinion on others. Very often it may be the other way round, for in these days of specialization a scientist is apt to become 'a man that knows more and more about less and less', so that his opinion upon subjects outside his field of special study is not necessarily of special value. Knowledge and judgement are two different things and do not by any means always go hand in hand, and there is always the possibility that a scientist's tendency to be wrapped up in his special subject may warp his attitude to outside issues of a more general nature. Scientist or layman, however, we have before us in the institution of this national scientific body the common intention that it must be fitted to pursue those purposes and ideals, which Professor Meghnad Saha so ably put before you last year, for the conquest of error, for the advancement of science and for the good of India.

I never realized, nor came near to realization of the vast field that there is in India for the organized efforts of science until the Census of 1931 put me into a position in which I could hardly overlook it. The first essentials of sociology are accurate statistics, and most of the few statistics available in India are obtained by crude methods and give results which are insuffi-

ciently exact. We know for instance that the population has increased but we can only guess at the causes; we cannot in India as a whole be certain of where or when the increase took place beyond locating it over a period of 10 years. In Madras alone was the registration of births and deaths sufficiently accurate for the population of 1931 to be determined approximately before the counting took place, and even then we cannot be sure that that accuracy was not an accident. How far the variation of fecundity in different parts of India is due to environment, heredity or social customs we have no means of knowing, since detailed local studies are wanting. Mr. Porter in Bengal has embodied in his Census Report for that province an interesting speculation on the future growth of the population of Bengal; but the figures on which it is based being limited to seven enumerations are not enough to warrant our taking it as more than a speculation. Even so it leads us at once to the urgent need of a greater application of science to matters of rural economy. It is probably true enough that improved methods of agriculture can so increase production that the population of this country is not in immediate danger of outstripping its potential food supply. But I say potential advisedly. It is very clear that in other respects the position is serious. The vast majority of India's population live an agricultural life not only by force of circumstances but by deliberate preference, and under their existing conditions of ignorance and of absence of capital, the population attempting to live by agriculture is likely to become, if it has not already done so, much too numerous for the land to support. The subdivision of holdings which are insufficient to maintain their owners, must tend to reduce the economic output from their land while the increase of cultivators and in particular of landless agricultural labourers calls for an increasingly high return from the land. In limited areas, and to a limited extent, some relief is afforded by seasonal industries (such as cotton in Central India) which enable the agricultural population to add to the income derived from land; in other areas cottage industries give similar assistance, but the extent of these reliefs is entirely inadequate to the need, and there is an obvious call for a great extension of part-time industries in which the cultivator can find employment when he is not required on his fields. To give one instance, it is probable, if not certain, that the application of scientific methods of breeding, feeding and selection could double the outturn of silk in India without any increase in the number of cocoons, and could at the same time enormously improve the quality of the silk. Indeed, for at least one Assam tribe the silkworm provides not only clothing but an article of food, as the pupa is much relished and reserved as a delicacy for favoured guests. But without seeking to popularize this use of the silkworm, the extension of silk producing, on scientifically improved methods, as a cottage

industry might make India easily the premier silk-producing country in the world.

Further, although at present there may actually be enough food in quantity to prevent the great majority of cultivators from going hungry, it is becoming increasingly apparent that their diet is very often extremely badly arranged. A very great deal of the disease in India is deficiency disease due more to a badly chosen diet than to actual scarcity of foodstuffs. This point is well brought out, for instance, in Mr. Yeatts' Census Report on Madras where he emphasizes the researches of Sir R. McCarrison on the causes of blindness in India, indicating that the widespread prevalence of keratomalacia is due to a diet deficient in fat-soluble vitamins. It is likely also that leprosy, to take another instance, is encouraged by deficiency diets. Sir John Megaw again, in his paper on *Population and Health in India*, tells us that in India, although three meals daily is more common than two, 'malnutrition due to unsuitable diet is the rule rather than the exception'. Here then is one practical task for doctors and health officers: that of prescribing a suitable diet within the means of the very poor conformable to the local products available in the neighbourhood. An example of what can be done in this way may be seen in Mr. Mukerjee's report on the Census of Baroda, 1931, where Dr. F. P. Antia and Mr. F. S. Kale give a food survey of the principal castes in the State. I would at this point put in a word of warning against those enthusiasts for reform and improvement whose zeal is greater than their knowledge. It is perhaps partly because the results of intemperance are so obvious and easily appreciated that the advocates of temperance are apt to be fanatic extremists, though I have known some who tempted one at times to recall Samuel Butler's caustic comment on the Puritans who 'compound for sins they are inclined to by damning those they have no mind to'. My point is that home-brewed beers form a very important element in the diet of the more primitive tribes and castes of this country. Not only does the very moderate amount of alcohol in these brews supply for certain purposes the want of sugar, which in many of their environments they cannot obtain, but the recent researches of Col. Chopra on vitamins have shown that the home-brewed beers of India contain many very valuable vitamins, and there is consequently a serious danger that propaganda or legislation directed to the suppression of the use of these liquids may result in the spread of deficiency diseases, and add one more tally to the lamentable tale of damage done by well-meaning but ill-informed tampering with customs that are disapproved by the reformer but are in fact useful adaptations to environment on the part of the ones to be reformed.

Unfortunately however it is not only rural economy which calls for the aid of the scientists; the rural call is, it is true, the

more urgent, not only because there are more than eight countrymen for every single townsman in India, but because the rural population is infinitely the more conservative; it is therefore in much greater need of that 'new outlook on life', the necessity of which is admirably emphasized by Sir John Megaw, in the paper which I have already cited, with a telling quotation from the concluding chapter of the Report of the Royal Commission on Agriculture. Such a new outlook is easier for the townsman to acquire, for in exchanging a rural for an urban life he comes into daily contact with new ideas and new ways of living. Unfortunately these ways of living are in some respects no improvement on the old. The Indian village, at any rate in northern, western, central and parts of southern India, often on a constricted site which cannot be expanded on account of the need of land for agriculture, is apt to be congested to a highly insanitary degree; but in towns this condition is often incredibly accentuated, and while 26% of Bombay's 1,161,380 inhabitants live under conditions of the grossest overcrowding, 74% of that population live in one-roomed tenements at more than 4 persons per room. Buildings of one story predominate in Indian towns, which makes the figures of congestion, when the population for a given area is compared with congested population in Great Britain, appear lower than they really are, but where, as in Cawnpore, tenement buildings are used, the congestion is almost incredible. One chak of the Anwarganj ward of Cawnpore contains a density of 786,560 persons to the square mile, a figure untouched by the worst of the metropolitan boroughs of London. Obviously there is a need for scientific planning in the outlay and growth of all developing urban areas if a repetition of this sort of scandal is to be avoided. It was a matter of considerable surprise to me to find that in many parts of India the existence of a town with a large and concentrated population was regarded as an occasion for pride and complacency. A large town appears much rather to me as a source of fear and repulsion. It is true that the work of such men as Sir Raymond Unwin have shown that there is no need for this, but nevertheless such parts of India as Assam, Malabar, and Eastern Bengal, where any close concentration of population is the exception, appear to be the more fortunate for that, and India has a wonderful opportunity of profiting by the experience of Britain and avoiding, by careful and scientific planning while her industries are still in their infancy, any further concentration of industrial population in congested areas.

I have referred to these points of rural economy, of diet and of town planning merely as instances of matters in which science may and should be utilized and directed for the benefit of the community; there must be many more which will no doubt be discussed by the various sections of this Congress, much more fruitfully than by me. There are however certain aspects of

my own special subject to which I propose now to direct your attention. India offers a vast field to anthropologists and opportunities such as exist nowhere else in the world, forming as she does a veritable museum of living physical types, of social organizations, cultures and religious beliefs. From the point of view of physical anthropology there is a vast amount of work to be done. India contains, in forms that are anatomically distinguishable, elements derived direct from the negrito races which constitute probably the oldest type of human being anywhere surviving. These elements are no doubt few and rare, limited to the Andamanese, rapidly alas becoming extinct, and to one or two of the remoter jungle tribes of the south of India. Similarly there are to be found survivals of that other eastern negroid race, the Melanesian. These survivals are more easily to be traced in culture than in anatomy, and it is not unlikely that the typical appearance of the Melanesian race itself is the result of hybridization. Nevertheless evidence is to be found of affinity in physique between some of the Assam hill tribes and the races of Papua and New Guinea, and it is probable that such affinities occur again in some other parts of India. On the other hand the physical type which Col. Sewell has conveniently labelled Proto-Australoid is widespread in India and Burma. This race possibly represents an early branch of the brown race of the south-east Mediterranean which migrated eastwards at a very early date and has been modified by environment to produce a markedly different type. On the other hand it may be connected with some of the recent finds in Palestine, which Sir Arthur Keith appears to regard as related to surviving types of man. These views are not necessarily mutually exclusive. This race is represented most strongly in the lower castes and in some of the aboriginal tribes particularly of southern India. These races have been followed by others whose order of coming is more difficult to determine. One race of invaders, probably likewise moving from north-west to south-east, must have brought in the Mon and Munda languages and possibly the keeping of sheep. Like their predecessors they seem to have formed definite connections overseas and to have moved on from India to Indonesia as the succeeding races did afterwards. It was perhaps after their coming that the Parocean or Mongoloid races began to come down from the north-east, particularly in eastern India and Burma, but whether they ever penetrated far into India except at a much later date is doubtful. There is a suggestion of the Mongoloid about many tribes, in the Madras Agency Tracts, for instance, but it is not clear that this element did not come in from the east by sea together with the returning wave of speakers of Mon languages which certainly came back from the east westwards into Assam. In 1930 Mr. J. P. Mills and myself published in the *Journal of the Asiatic Society of Bengal* an account of some stone funerary urns

found in the North Cachar Hills, which were then, as far as we could ascertain, unique. Since that date groups of very similar urns, used for an obviously identical purpose, have been discovered by Mdlle. Colani of the École Française d'Extrême-Orient in Tonkin in Indo-China, so that the Khasi-Synteng group in Assam can now be connected with the Far East culturally as well as linguistically.

And here is a point at which the geologists can help us. I have suggested elsewhere that a wave of immigration into India from east or south was caused by the subsidence of the mass of the Indian Archipelago. There are traditions among the hill tribes of Assam, Burma, Eastern India and the islands themselves which seem to me to point to a great volcanic cataclysm and a submergence of land under the sea which drove them to escape into the hills and ultimately to migrate; Messrs. Peake and Fleure, in that admirable series *The Corridors of Time*, have pointed out that if the coast line of the Indian Archipelago be extended to the hundred fathom line a great land mass appears which very nearly joins the Asiatic continent to Australia, and that some such reconstruction is necessary to account for the early occupation by man of the Australian continent; Molengraaff and Weber in their work on the zoology of Indonesia have pointed out that the distribution of the species of freshwater fish in the islands suggests land continuity up to a comparatively recent date. The suggestion I made of the migration of certain tribes as the result of a volcanic upheaval and submergence met with quite definite disapproval at the hands of the geographers to whom I propounded it last year in London, but since then I notice that Corbett and Pendlebury in their work on the butterflies of the Malay Peninsular have been led independently to a precisely similar conclusion to that reached by Molengraaff and Weber when working on the fish; I think I am justified therefore in stirring up the geologists to re-examine the possibility of the subsidence of Indonesia after its occupation by man, and at what is, geologically speaking, a recent date.

Whatever the provenance of the Mongoloid element in India, however, its physical influence appears to have been very small, and the main bulk of India's population would appear to be of Mediterranean origin, and it is possible to show much evidence for a continuity at a very ancient date of both race and culture from south-eastern Europe through Asia Minor, Syria, Mesopotamia and Iran to India. Into this population brachycephalic elements have entered probably coming both in the form of an admixture with the civilized Mediterranean and also in the form of a definite brachycephalic migration which has affected certain areas in India, of which Bengal is one, very much more strongly than others. It is possible that this latter brachycephalic element brought in the Pisacha or Dardic branch of the Aryan

language, a purer form of which followed with the dolichocephalic Aryan invasion of about 1500 B.C. This difficult question I have discussed at greater length elsewhere, and I do not pretend to regard the position advanced as conclusively proved and established. What I do urge is that the question of race in India is one which calls for very careful and detailed examination by trained anthropologists on the lines recently adopted by Dr. Guha of the Zoological Survey and those workers who have been assisting him. The method of working by the coefficient of racial likeness is laborious and involves an amount of mathematical calculation which is more laborious even than the taking of the measurements, but results of permanent value cannot be obtained without the initial labour, and this should be extended to all parts of India and to every tribe and caste. It should also be supplemented by a corresponding analysis of the blood groups of such castes, since it is possible, if not probable, that these may give no less important indications of relationship than anthropometrical measurements. You have in India in the caste system a most valuable opening for approach which is denied to other countries where racial mixtures have gone on in a far more promiscuous way than they have in India. I do not suggest of course that caste is any necessary criterion of race. I feel certain that it is not, but it has divided up the population into endogamous groups which must have very greatly retarded and restricted the extent of miscegenation, and investigation is urgently called for before that system begins to break down under modern conditions. Meanwhile that same system affords opportunities for the study of human genetics not found elsewhere; it also opens up an approach to the study of the effects of environment on physique, since if castes which can be shown to have had a common origin and to have kept their strain pure, but which are now domiciled in different parts of the peninsula, are found to differ physically, the differences may be examined to see how far they can be traced to climatic or to other environmental causes.

In prehistoric archaeology there are any number of sites awaiting excavation, and it seems highly probable from finds that have been made in Bihar that the Mohenjodaro civilization extended not only to the Indus valley but to the valleys of the Jamuna and the Ganges as well. We do not yet know the meaning of the ideographs used by the people of the Mohenjodaro civilization, nor what was the language used. It seems likely that it was a Dravidian tongue, but it might conceivably have been a Munda one. A mere reference to Munda is enough to remind one that our serious lack of knowledge of the distribution of this language shows how great is the necessity of linguistic research in southern India. Sir George Grierson's great work on the languages of India did not include the province of Madras, and we have no knowledge whatsoever of whether

any trace of the Munda or Mon linguistic family exists south of the Godavari river or not. I suspect myself that such traces will be found in the uplands of Mysore, but that is a pure guess. An extension of the linguistic survey to the whole of south India is urgently needed ; meanwhile we cannot tell whether the Munda speakers ever penetrated to the south or not, nor what traces, if any, survive of any of the languages that must have preceded Dravidian there. But we ought not to be content with mere linguistics. There is a branch of research in which so far as I know very little indeed has been done in India, but which if taken up comparatively is likely to lead to valuable results. I refer to the symbolism of dreams. Such work as has been done on this subject in Europe tends to show that the symbols of dreams are of universal application. Thus to dream of the loss of a tooth foretells the death of a relative in all parts of the world ; most often, but not necessarily, it refers to a maternal relative, which is perhaps in itself significant. Now Freud makes a suggestion that the dream symbols used by the 'sub-conscious' to avoid the censorship of the 'ego' may be the survival of a symbolic language in use by the human race before any language, as we understand the word, developed. It seems not unlikely that when primæval man got beyond the stage of chattering, squealing, and grunting in different tones of voice, he communicated by means of a very limited vocabulary in which one word or symbol had to serve all sorts of different meanings connected only by some real or supposititious similarity in the objects named. The suggestion is an interesting one, and I would recommend a comparative research into the dream symbols of various castes and tribes as one which might throw some light on the pre-existence or otherwise of such a symbolic proto-language, and which would at any rate test the claim which has been made that dream symbols are of universal application. It has to be borne in mind of course that conventional interpretations of dream symbols may have been communicated, at a much later stage in human evolution, from one people to another in the manner in which folktales have spread all over the world, and that the diffusion or universality of conventional interpretations of dreams is not necessarily relevant to the hypothesis put forward by Freud, in which the symbol is used by the sub-conscious self in cases in which the ego disapproves and suppresses the use of a more easily recognized vehicle of expression. Here the interpretation is not available until supplied by psychologists.

In the study of folk-lore proper only a beginning has been made in India, and a vast deal of material is disappearing very rapidly under the influence of missions and of the general change in the manner of living which is being brought about by the opening up of communications generally. Dr. Bake, a Netherlander, has recently been working at Indian folk-music and has shown

as what *can* be done by an enthusiast, while Bengal has set an example to other provinces in a revival of folk-dancing.

Turning to religion we find in India beliefs and practices which seem to have survived from a very early date in human history like flies preserved in lumps of Baltic amber. Thus traces are easily found, not only in tribal beliefs, in which the principle is sometimes specifically formulated, but in folk-religion as distinct from orthodox dogma, all over India of a belief that life is a finite and material substance. It is this belief in the transferability of life, so to speak, that underlies the practices of head-hunting and human sacrifice, though in the case of the latter the ideas of propitiation and expiation have doubtless entered later at a sophisticated stage when the original idea which gave rise to it had begun to fade. It also underlies many funeral practices in this country which are arranged with a view to the transference of the life-matter to the crops, whereby it is again consumed by human beings and used for the propagation of fresh individuals by the begetting of offspring. Elsewhere I have pointed out that the same idea appears to be the basis of the practice of temple prostitution. Now I suggest that this idea of life as a material substance arose very early in human pre-history. Primitive peoples to this day have great difficulty in expressing anything but a concrete idea; primitive languages are apt to contain no words for abstract ideas. Clearly the inference is that at a primitive stage of thought only concrete things can be conceived of, and the first man who reflected upon the difference between a dying body and a dead one conceived of that which had left the body as some material substance which had leaked out of it, which is very much how the Karen states the case at this day. This view of the nature of life is not only common throughout India in tribal religions but may be traced in Hindu philosophy. The Vedanta conception of the soul with its successive sheaths is probably one instance, and a more concrete one is to be found in Manu's condemnation of the Teli and his relegation of him to an outcaste position on the ground that he is a destroyer of life by crushing the oilseed for the extraction of oil; hence the distinction in Bengal between the Teli who crushed the seed, and are therefore outside the pale, and the Tili who merely traded in it without having committed the sin of destroying life. Another instance of the way primæval things survive in India is perhaps to be found in the common prejudices in regard to red ochre. When arranging for the numbering of houses in the 1931 census I found that red ochre was a desirable pigment to recommend because almost all over India the use of red ochre is regarded as fortunate, and while people are likely to object to numbers tarred or painted on their houses, the affixing of numbers in red ochre was regarded as more lucky than unsightly. I do not know the cause of this, and I do not know that anyone

knows why this superstition attaches to red ochre, but it struck me at once that it might well be a survival of some belief that was obviously at work in the old stone age. It is clear from many prehistoric finds that palæolithic man treated the bones of the dead with red ochre and the find at Offnet of a large number of heads so treated without the appropriate skeletons suggests that the use of ochre may have at one time been associated with the practice of head-hunting or with that of a separate disposal of the head in burial, a practice still popular in parts of the hills of Assam, where it was once more prevalent than it is now, in parts of Burma, of Indonesia and of Melanesia.

I have said enough to indicate I think the enormous field there is in India for anthropological research. What is most wanted at present is the organized collection of facts, of facts, that is, uncoloured by any preconceived ideas. Facts once collected and put on record can be interpreted at any time, while premature interpretation is too apt to predetermine the actual facts collected, and all the time precious material is disappearing at a rapidly increasing rate. The tremendous change which motor transport has introduced into India has only just begun to be felt, but the general improvement in means of communication is indicated by a rise in 1931 in the figures of every form of road transport except those of palki-bearers, who show a not very remarkable decrease, and a rise in the figures of persons employed in the construction of means of road transport, and a corresponding rise of over 300% in the figures of owners, managers and employees connected with mechanically driven vehicles. This change is having an incalculable effect on country districts, and you must expect to find that an incredible quantity of traditional belief and custom will disappear in a generation. Change has been fast enough in Britain. I can remember as a child taking part in more than one Easter egg-rolling, and you may search very far before you can see one there now-a-days, and I can remember watching the performance of what must have been one of the very last bands of the old folk sword-dancers before the artificial revival of folk-dancing; but in this country I have seen whole villages entirely abandon their ancient customs in the course of a few years, and there are no written records by which the rising generation of such villages can have any knowledge at all of the practices of their own fathers. It is therefore to the collection of the existing material of folk tradition before it is lost that this generation of Indian ethnographers is called, and I would further urge that intensive work on a limited area is far more valuable than extensive work which necessarily involves generalization. That can always be done later. Local differences are often very great and the minor differences found from district to district may be of great significance. Different areas with different environments need different treatment, and it seems to me that we suffer much too

much already in India from too much centralization, and too much generalization in every form of activity.

The question is likely to be asked what, if any, is the practical value of a study of anthropology. I offer no categorical answer to that question, but I do offer a few instances in which its practical value is sufficiently obvious. Thus in Africa the substitution of Indirect Rule for the older system of direct administration is the immediate result of applied anthropology. Indirect Rule is an educative system and its objective is to evolve by a natural process an indigenous system of administration which shall conform to civilized standards without jettisoning what is good and environmentally suitable in the native systems which Direct Rule must completely obliterate. To quote the Report of the Kenya Land Commission :—"The principle is that it is better to take the native customs as they stand and build from them as a basis, than to rely upon some novel but imported pattern which would not be understood—" Such a principle involves of course not only the knowledge of what is but of what has been ; the knowledge of the origin and *raison d'être* of customs and belief, since no complete understanding of these is possible without the knowledge of how and why they came into existence and developed as they did. The experiences of Africa have an important bearing on the administration of the more primitive parts of India, and it would probably be wise in our administration of tribal areas to look for light not from the east but from the dark continent. *Semper aliquid novi Africa adfert*, and although the system of Indirect Rule has lately incurred much criticism and may in some cases have been carried too far, we have had only too little of it in India. Anthropologists have been accused, incidentally by Mr. Jayaker, of wishing to create for their own edification living museums of people whose sophistication is retarded to their disadvantage. In point of fact this criticism is most unjust. What the anthropologist does seek to do is to apply his acquired knowledge and experience so to modify contacts between primitive and advanced cultures that the former may not be, as they so often have been, ruthlessly extirpated by the latter, a process invariably accompanied by the decimation, if not annihilation, of the races whose culture is destroyed.

At the same time the answer to any question as to the practical value of anthropology must obviously depend to some extent on the circumstances under which the question is asked, and in the case of this country I would suggest that, apart from any administrative question, anthropology may be able to provide a solution of certain problems of very great importance to the people of India. India shows a marked contrast to Europe in that the number of males exceeds the number of females ; various explanations have been sought in differences of climate, differences of race, or differences of social custom, but

no one has yet studied the subject so thoroughly as to be able to offer us any convincing explanation of the phenomenon. Again, it is for the anthropologist to consider and determine not only its causes but what will be its results. It is both contended and disputed that in-breeding leads to an excess of masculinity. If that be true (and there are weighty opinions on that side) then the caste system is likely to be one factor in producing this excess of males. If so, will such an excess have a good result or a bad one? In the former case caste is clearly an institution to be cherished; in the latter case we ought to do all in our power to encourage intercaste marriage. Here is a problem for the examination of anthropologists, a research problem of very great practical importance. It is not so much for the anthropologist to say whether or not an excess of males is a bad thing, as to determine the causes and consequences of such an excess; to say whether the observance of caste is a factor therein and whether intercaste marriages tend to produce a more even balance of sexes. An enquiry of this kind should not be an impossible matter in a town like Calcutta. Sir John Megaw, in a much discussed paper read last February before the East India Society, emphasized 'the urgent need for the people of India to adopt a new outlook on life'. Such a new outlook can, I claim, be supplied by anthropology, which should teach us to 'see life steadily and see it whole'. Life is very largely governed by custom and prejudice, and often so rigidly that these factors amount to tabus, for tabu in its broader sense is no foible confined to savages but an attitude of mind which they share with the most civilized, and which is common to all religions which depend on any hierarchical organization or any schematic creed. Untouchability as observed in India is a precise instance of tabu. Tabus when they arise, may be admirable and even necessary, but like all religious dogmas tend to survive long after the necessity has declined and their moral justification has vanished, a survival which is often to the moral, social, or economic detriment of the community which holds them. Many instances of this might be given but it will be enough here to mention a tabu on the planting of rice in certain Naga villages. Where agricultural operations are carried out very largely by the work of the community acting together, it is obviously necessary to control the inception of successive stages, and to maintain their control, a tabu is laid upon sowing and upon transplanting before the controlling official gives the word by an inaugural ceremony. Otherwise there would be a tendency for those whose fields had completed one stage with the help of their neighbours to go on to the next instead of helping the rest of the community to achieve a similar completion first. The successive operations of the agricultural year are therefore all governed by a series of ceremonies and tabus, the inauguration of which has been fixed at the time which experience has shown to be most suitable in

the environment. So strong has the respect for these inaugural tabus become, that people migrating from one area to another have frequently continued to refer to the village of their origin for the dates of the ceremonies to be performed in their new village, and have thus perpetuated an agricultural calendar which is not suited to the changed environment, and although they themselves recognize that at their new and, for instance, lower and warmer altitude an earlier sowing or transplanting would be advantageous, they prefer from religious or superstitious reasons to retain the dates suited to the village of their origin and to suffer considerable economic damage as a result. Similarly the system of *tabu* was probably essential to the authority and position of the Maori chiefs, but so strong was the prohibition on touching one that a case is on record of a chief who was rescued by a missionary on the point of suffocation from a fish-bone stuck in his throat which none of his people could remove on account of that *tabu*.

Now the reason why *tabu*, useful in origin, is carried to an extreme which is merely damaging is that it has a definitely religious sanction, and all religious sanctions tend to be not only dogmatic but extremely rigid. This rigidity is no doubt a quality necessary to their enforcement to the first instance and to their survival of their initial inconveniences. At the same time its ultimate effect is to take such injunctions as, for instance, 'what God has joined let no man put asunder' and 'thou shalt not commit adultery', and interpret them so stringently as to make them prohibitive of divorce or of the remarriage of widows under any circumstances at all, giving us a stone for bread.

Professor Haldane has recently drawn attention to the fact that human morality is usually relative. He refers to that father of modern science Aristotle, who, he says, 'saw clearly enough that right and wrong are usually quantitative. Thus according to the amount of risk taken in a given situation, conduct is judged to be cowardly, cautious, brave or rash. There is an optimum somewhere between two extremes just as there is an optimum temperature for a growing plant'. He goes on to point out that the principle is 'perfectly familiar in science, as when a substance exhibits new properties with rising temperature, or an aggregate of many similar molecules displays characters not found in a single one'. The conclusion he draws is that a human code of ethics must be plastic and capable of adjustment to changes in the economic structure of society, and a code which is rigid is a dangerous anachronism. It is, however, the tendency of all hierarchical codes to aim at rigidity regardless of environment. It is just that spirit which, to use two more of Professor Haldane's illustrations, induced British bishops in the early XIXth century to vote in the House of Lords against a bill to abolish the penalty of death for stealing by children under 16, and in this XXth century to oppose the

legitimization, by the subsequent marriage of their parents, of children born out of wedlock. It is the same spirit which is abroad in India opposing changes in the marriage laws or the entry of exterior castes into temples. Because a mediæval widow must burn with her husband or live celibate till her death, her remarriage is still discountenanced; because a thousand years ago it was considered advisable to marry off a daughter before she reached puberty therefore it is a sin not to do so to-day. There is ample evidence that the relative proportions of the sexes at certain ages differ in India from those in Britain largely on account of the great mortality among girls who are married and caused to bear children before they are physically fit for it. Yet the Sarda Act is virtually a dead letter and the interval between its passage and its taking effect was used to perpetrate an enormous increase in infant marriages, not only among Hindus but also among Muslims and Christians. A careful investigation into the causes of death in childbirth in Madras showed that in 6% of all confinements the mother was under the age of 15, and if any one needs light on the excessive mortality among Indian girls aged between 15 and 30 he has only to turn to the Report of the Age of Consent Committee and the horrid volumes of evidence attached. Clearly there is need for the new outlook referred to by Sir John Megaw, particularly in the more rural parts of India.

Another end which I believe that anthropology can further, is that of a better understanding between nations and races. Nor do I refer merely to the very obvious need of a mutual understanding between Britons and Indians. Misunderstandings exist no less between different racial and social elements within India and are in just as much need of liquidation. It is a commonplace that to know all is to understand all, and clearly a knowledge of the characteristics and genius of an alien race as determined by their composition, their history and their environment is likely to make it easier to allow for points of difference and to appreciate by standards that are other than our own. The increasing ease and rapidity of communication is causing the world to shrink with a speed which is very disconcerting, and unless we can learn to put up with, as neighbours, peoples and nations that were merely names to the bulk of our forefathers, we shall find it an uncomfortable place to live in. Change is proceeding at a pace that rapidly increases as it goes along, *vires acquirit eundo*, and although in India it has been extraordinarily slow in the past, it is already very much faster and may become extremely fast in the near future. The geographer Ptolemy writing nearly two thousand years ago referred to the Nagas and placed them on his maps approximately where they are to-day, but though the name remains, he would no longer recognize their country as the realm of the naked, though this change has been taking place only in the last few

years, and may not yet be regarded as complete. But nearly everywhere in rural India the last 20 years has witnessed a tremendous change in the standard of living and a very rapid introduction of new ideas and new practices. *Tempora mutantur et nos mutamur in illis*, 'times change, and we to fit them', may still be true, but for a great many of us the change is becoming too rapid to be at all comfortable, and there is real danger that the more backward may be entirely destroyed by failure to adapt themselves to the changed environment. What the anthropologist seeks to do is to control their contacts with a more sophisticated civilization in order that they may have a reasonable chance of adapting themselves to a changed environment and escape that complete destruction by disease and vice that contact with civilization has brought to so many people of comparatively primitive economic culture. The object is not to chain the individual to his existing environment, but by giving him the opportunity to adapt himself to changes at his own rate, to enable him to control his environment by the development of his own culture. The attempt to 'civilize' has generally meant an attempt to make in a hurry a perfectly good savage into an unsatisfactory or useless imitation of an inferior Bengali or an inferior European, unsuited to the surroundings in which he finds himself and able only to subsist as a parasite on society if he can be found what Nagas describe as a 'sitting-eating job'. It is against this process in any of its many forms that anthropologists seek to take precautions, and it may be claimed that at least in Africa they have effected something, and I am one of those who think that it is still not too late in parts of India and Burma, and that we can do no greater harm to people who have a culture of their own already adapted to their environment, than to filch it from them, before they have any means of appraising comparative values, by the substitution of another, unsuited to the environment and disguised under the insidious pretext of 'uplift', which so often merely substitutes new tabus for old, while leaving the attitude of mind, the outlook on life completely untouched. The only case I know of in which the mere museum-of-exhibits policy could be justified is that of the Andamanese, who are probably so far removed from the conditions of modern life and from any qualifications for sharing it, that it is to be doubted whether adaptation is at all possible, without completing the destruction of what is left of them in the process. Fifty years of contact with the penal settlement in Port Blair has already reduced their numbers from over three thousand to a mere 450. A strict isolation is probably their only chance of survival, and they really ought to be preserved from extinction if only as scientific specimens of a type of human being elsewhere long vanished from the face of the earth.

Finally, anthropology like any other science is worth pursuit for the sake of knowledge alone. Great advances have been

made in those sciences which give us knowledge of our environment. Geologists can tell us the composition and history of the earth and astronomers penetrate yearly further into space. Great advances have likewise been made in the sciences such as chemistry and physics which give us control over material substances and physical forces—but the merest beginning has been made in those sciences which give us knowledge of ourselves, a knowledge without which we can never hope to control the destiny of our race. The science of anthropology is the first step towards the acquisition of such knowledge. It has taken man about a million years to reach his present state of existence, and Sir James Jeans estimates that the earth will remain habitable for a million times that period again. What the human race will be like if it survive to such an æon, is clearly beyond the imagination of man, but one thing may be taken as certain and, that is, that it will need all the knowledge it can have of its past and its present, of its nature and composition, and of the controls, if there be any, of its own development, if it is to succeed in adapting itself to the changes inevitable in so great a period of time. It is impossible to say what trifle may not lead to important discoveries, or that knowledge of no practical value to one generation may not be invaluable to the next. Meanwhile much material of great importance to anthropologists is disappearing all too rapidly, and we must search for knowledge and for truth while there is yet time. A philosopher of old has told us that Truth is great and shall prevail. Gentlemen, that philosopher was very clearly one great optimist, but even though we may see small sign of the prevalence of Truth in our generation it is all the more our duty as scientists to do all that in us lies to make her paths straight.

Section of Mathematics and Physics.

President :—DR. N. R. SEN, D.Sc., Ph.D.

Presidential Address.

THE DEVELOPMENT OF MODERN THEORETICAL PHYSICS AND ITS LIMITATIONS.

The history of many nations shows the peculiarity that the culture and national traits of the living generation have few things in common with those of their forefathers living hundreds of years before. Still there is a great bond uniting the two peoples living far apart in time: the bond of *continuity*. The history of physical science during the last three hundred years reveals to a certain extent the same features. If we were simply to look at the chasm that separates the physical ideas of the days of Galileo and Newton and of the later days of Laplace, Poisson, Coulomb, Oersted, Gauss and Weber on the one hand, and the modern microphysics with its Wilson chamber, quantum jumps, electronic phase wave and uncertainty relation on the other, the construction of a bridge across this would certainly appear formidable, if not hopeless. But the course of the development of physical thought really shows very little of bottomless gaps or ways lost in wilderness, but a continued carefully planned path, though here and there, there exist some turns and even hairpin bends. The common notion that Relativity mechanics has completely thrown overboard Newtonian mechanics and has built up a structure in which the achievements of classical mechanics have no place, is no more true than the Calcutta Municipal Corporation and Improvement Trust have been able to obliterate this city by covering its roads with tarmac, extending its boundaries, by building new roads in congested portions and providing new means of communication, which have undoubtedly given this city an entirely new look. Even the newest Wave mechanics maintains its close bond with Hamiltonian mechanics by borrowing dynamical forms from the latter, though its operation and interpretation are different. It is this principle of continuity which we find so poignantly expressed in Bohr's Principle of Correspondence. The spirit of the Principle of Correspondence, according to a recent statement of its originator, is to be looked for in the tendency to preserve in tact all those ideas of classical theory, which do not lead to results in contradiction with specific atomic phenomena. Before we pass on to the consideration of the New Mechanics with its achievements and limitations, and try to anticipate the lines on which further development is to be expected, it is necessary that we should

not only know the course by which the present position has been reached, but also place on the forefront the keynote, as it were, of this progress, which I easily identify to be this principle of continuity in the sense of Bohr.

Modern theoretical Physics may be supposed to date from Newton who has given us his famous laws regarding motion of material bodies. The law of motion is expressed as an equation, one side of which contains the material constant with the time variation of some characteristic of motion, while the other side represents interaction among material bodies usually expressed as force. The whole process of interaction among bodies separated by distance is embodied in the Law of Universal Gravitation, which postulates attraction between two bodies, proportional directly to their masses and inversely as the square of the distance between them. Two points may here be noted, which later served as starting points for further development. Firstly, the Law of Gravitation is silent about the mechanism by which Gravitation is brought into existence; rather it frankly takes for granted the action at distance and does not conceive an intermediary for the propagation of this action. Secondly, the same material constant, represented by mass, plays a dual rôle. Every material body creates a gravitational field whose significant portion is in the neighbourhood of the body. This field is proportional to a constant of this body, which we call its gravitational mass. On the other hand, the same body will react to a gravitational field in which it may be placed, and in the measure of this reaction appears a material constant which is its inertial mass (which appears on the left-hand side of the equation of motion). That these two constants, the gravitational and inertial masses, are one and the same, was looked upon more as an accident than as some unifying principle in the phenomenon known as Gravitation. Into this gap left in the Law of Gravitation, jumped in recent years the Theory of Relativity which we shall have occasion to discuss later. Newtonian Mechanics was designed for a description of the behaviour of large masses and deals with quantities which are measurable. The wonderful success which this Mechanics attained, even went so far as to influence the outlook of men in the nineteenth century and after, on Life and the External world. The only conceivable scientific system for an investigator in any branch of Science was a mechanical theory. It is no wonder that this Mechanics, though primarily conceived for large masses, and verified beyond doubt in such cases (the most notable being Celestial Mechanics), should be extrapolated and applied in the microscopic world of atoms. It was only then that its limitations were discovered. We can now safely say that till this limit of the microscopic world is reached, classical Newtonian Mechanics reigns supreme in all mechanical (as opposed to electromagnetic) phenomena. There are reasons

for believing that a limit in the other direction, namely for very large mass concentration, also exists, but our experiences in this direction unfortunately are so limited that no great claims for this idea can as yet be established.

The Mechanics of Newton was considerably developed in later years and we owe to William Rowan Hamilton, the invariant variational form in which the entire mechanics was epitomized. Hamilton showed that all mechanical equations can be obtained when the time integral of a certain dynamical function, called the Lagrangian function (being the difference of kinetic and potential energies of the system), assumes an extreme value under suitable limiting conditions. This is known as the Principle of Least Action. More recently, this Variation Principle has been very much in vogue in other branches of theoretical Physics for some important advantages which it offers. Almost the last stage of the development was reached when it was shown that the solution of any problem can be made to depend on the solution of a partial differential equation, known as Hamilton Jacobi's equation. For a closed system in which no influence from an outside system is permitted, one side of this equation is constant, namely the total energy of the system. This method has many applications in the many-body problems of celestial mechanics.

The early development of the electrical theory was based on the Coulomb's Law of repulsion or attraction of like or unlike charges. The history of this development in two countries is interesting. In Germany, the names of two great mathematicians, Gauss and Weber, are connected with it. Between them the entire mathematical theory based on Coulomb's Law, or the principle of action at distance, was worked out. In England, Faraday pictured the lines of force in the space round electrical charges, and can be considered as the originator of the Field theory which received its final and beautiful shape in the hands of Maxwell. The entire Electrodynamics was formulated by Maxwell in two linear partial differential vector equations of first order. The essence of this Field theory is that the theatre of action is transferred from the seat of the electrical charges to the space surrounding them, in which the entire electric and magnetic energies are supposed to be stored. With every point in space are associated two vectors: electric and magnetic field intensities, and the time flux of any vector at a point is connected with the rotation of the other. The electromagnetic phenomenon is thus spread over the whole of space, and the action at any point is connected differentially with the action at the neighbouring point. In the Field theory the Integral Law of Coulomb is replaced by a set of Differential Laws. In all statical Fields or Fields varying *slowly* with time, either method is quite as good as the other, but the superiority of the Field theory is clearly manifested when describing pheno-

mena changing very rapidly with time, where the idea of action at distance cannot carry us far. As a matter of fact, Maxwell's equations lead, on elimination, to the well-known wave equation for the magnetic and electric vectors. These waves carry the electromagnetic action from one part of space to another. The electromagnetic wave in vacuum was identified with the Light wave in free space. This idea has received the support of experience and has been so fruitful in all later developments that since then the link between optics and electricity has been taken to be definitely established. The rôle of the medium which is the seat of electromagnetic action, has been found by allowing known material substances to take the place of free space. As stated before, the success of the mechanical theory tempted physicists and mathematicians to construct a mechanical theory of electromagnetism, and Kirchoff actually succeeded with certain assumptions in establishing the Maxwell equations from Variation Principle, in which magnetic and electric energies respectively played the parts of the kinetic and potential energies of the mechanical theory. The mathematical prediction of Maxwell found fruition in the experimental genius of Hertz in Germany, and the names of Maxwell and Hertz have always been associated with the Field theory.

After the discovery of the electron and the X-ray, the Field theory underwent some important modifications in the hands of Lorentz. Maxwell's theory makes the refractive index of material bodies independent of the wave length of light traversing it, in direct contradiction with experience. Lorentz considered material bodies to contain electrons which are only grouped differently in different bodies. The electromagnetic wave in free space, which Maxwell identified with Light spreads, according to Lorentz in a hypothetical medium pervading all space, called Ether. Lorentz gave further a set of equations analogous to those of Maxwell, describing the behaviour of the electron in free Ether. In addition to two vectors corresponding to electric and magnetic intensities, a quantity called the electric charge density is introduced which is identified with the divergence of the electric vector. In plain language this means the electron is regarded as the source from which the Field flows. There being no corresponding free magnetic charge, the divergence of the magnetic vector vanishes. A distinctive character of Lorentz's theory is the *ad hoc* introduction of ponderomotive force in the electromagnetic field, known as Lorentz force. Its form is so chosen as to be consistent with the Principle of Energy. Considerable simplification is made by introducing four quantities known as four potential, and the wave equation is reobtained, by which electromagnetic action is propagated from one point in Ether to another with the speed of Light. On the basis of his equations, Lorentz gave a satisfactory theory of the phenomenon of Dispersion, of normal Zeemann effect,

and was able to explain many other optical properties of material substances. The net result was a conviction among Physicists in the electrical origin of matter. The tide was thus reversed. While previous generations of Scientists attempted to reduce every natural phenomenon including electromagnetism to mechanics, henceforth, there arose the tendency to explain mechanics in terms of electromagnetism.

The equations of Maxwell and Lorentz have a consequence with which all later developments are connected. A charged body or an electron in uniform motion will simply drag its field along with it, but an accelerated charge loses energy which spreads out in space being carried by spherical waves. This is what is known as Radiation. The simplest Radiator is an electron executing harmonic vibration, which to the Physicist often serves as a simple electromagnetic model of Light. It is this feature of the Field theory which historically has played the prominent rôle in leading the way to the new Quantum mechanics.

Summing up, the Field theory succeeded in connecting electromagnetism with optics, generally identified the electron as a fundamental ingredient of matter, and furnished a theory of Radiation which apart from the question of the production of radiation or its extinction, and distribution of energy in it, was found quite satisfactory. The unsatisfactory features of the electron theory may also be noted. Firstly, the question of the dynamical condition of Ether bristled with difficulties, and various attempts were made to avoid them. Secondly, an attempt at a conception of the structure of the electron also revealed difficulties of a fundamental nature. The idea of a point electron was untenable. The total energy of the electronic field is expressible as an infinite integral of the inverse square of the radial distance from the electron. The zero value for the lower limit of the integral corresponding to the point electron, would give infinite value for the energy. The only way to get round this difficulty was to give to the electron a definite radius. Abraham considered a rigid structure for the electron, while Lorentz, for certain advantages assumed the electron to contract in the direction of motion. This could not, however, avoid falling into another difficulty. The momentum and energy of the finite electron did not satisfy the usual energy momentum relation, so that to uphold the energy principle, it became necessary to attribute nonelectromagnetic energy to the electron. In fact, Poincaré showed that in order that the electron might not blow up, a definite mechanical pressure, usually called Poincaré's pressure, on the electronic surface was necessary. These difficulties arose when a definite structure for the electron was suggested.

Before we discuss phenomena which the Field theory was unable to explain, we may mention some refinements which the

theory received with the advent of the Principle of Relativity. It was known that the Newtonian equations of Mechanics admit a group of transformations known as Galilean group, which means these equations retain their forms unaltered in inertial systems, that is to say, as one passes from one system to another which moves uniformly relative to the first, the time being regarded as a variable identical in all systems. The electromagnetic Field equations admit another totally different group of transformations, known as Lorentz group, which refers to transformation from one inertial system to another, each system here having associated with it its own time. This latter corresponds to the experience obtained after careful measurements, that it is impossible to ascertain the (uniform) motion of a system by measurements made in that system, which has been taken by Einstein as a postulate of Relativity. The idea of a time being associated with every co-ordinate system places every physical fact called Event in a new setting of space-time, and ultimately introduces wonderful simplifications in the description of nature. The requirements of the restricted Principle of Relativity necessitate a formulation of natural laws in covariant equations, so far as motion of uniform translation is concerned. This desired form was given to the Field equations by Minkowski, a mathematician of Göttingen. The covariant equations immediately showed a wonderful symmetry as regards the parts played by space and time, and the intimate relation between electric and magnetic phenomena, facts which are invariably masked by the use of ordinary cartesian co-ordinates and separation of space and time. The idea has since then grown that all equations having a claim to be called natural laws should satisfy the condition of invariance under Lorentz transformation. We shall see that it is this endeavour which has, in the domain of new Wave Mechanics, given us the best system we as yet possess.

The attack on the Field theory for its incapacity to explain small scale phenomena, such as those connected with structure of the electron mentioned above, as well as those connected with the production and absorption of light came from different directions. The study of Spectroscopy revealed the fact that atoms of elements emit characteristic radiations which may be utilized for identifying the atoms themselves. A theory of the constitution of the atoms presented considerable difficulties. Atoms are certainly very stable structures. The linear character of the Field equations suggests a prima facie difficulty for the electrical constitution of atoms as definite structures, as given a solution representing an atom any constant multiple of the same solution should also serve the same purpose. Moreover, if the characteristic radiations of the atoms are due to the motion of accelerated electrons within them, these electrons would continuously lose energy making the stability of the

atoms impossible. The Field theory of Radiation is incompatible with the idea of internal electronic motion on classical lines and the stability of atoms. Take again the particular case of X-ray spectra. From the point of view of the Field theory the problem is intimately connected with the classical conception of free and forced vibrations of electrons. The radiations corresponding to these vibrations were not finally separated till after the work of Laue and Bragg. It was then recognized that the radiation corresponding to free vibration of electrons in the anticathode is essentially discontinuous in character, whereas the portion of radiation independent of anticathode has a continuous structure. About 1916 it was further discovered by Duane and Webster that the continuous part of the spectrum has a sharp end. This is exactly opposed to what one should expect from classical electrodynamics. The classical radiation, decomposed into its components by Fourier integral, should have a spectrum extending up to infinity, just as in a vibrating string. The truncated spectrum can only be explained by the introduction of quantum hypothesis. Coming to photoelectric effect, it was found by Hertz and Hallwachs that when ultra-violet rays fall on some metals electrons are emitted. The velocity of the electrons, first measured by Lenard is not dependent on the intensity of incident radiation but on its frequency, a fact which the wave conception of radiation is hardly able to explain. But historically, the problem which was first solved by the introduction of quantum hypothesis was that of distribution of energy in the spectrum of a black body or a body which absorbs all radiations falling on it. Rayleigh and Jeans gave a formula which is applicable to radiation of large wave lengths in the infra red, while for high frequency in the ultra-violet another formula due to Wien based on the Field theory is found to work well. The measurements of Lummer and Pringsheim brought this into evidence and showed the necessity for a general formula true for all wave lengths. It was soon realized that classical theory would lead inevitably to these results which are true only in extreme cases. Planck in 1900 struck out an entirely original line of thought, by imagining radiant energy to exist in granulated form. Each grain, called a quant, contains energy equal to the product of the frequency of radiation and a universal constant h , called Planck's constant. The continuous structure of energy is replaced in this hypothesis by a discontinuous structure. This was an innovation which the Field theory was unable to accommodate, but with the help of this Planck ultimately obtained the correct Radiation formula.

With Planck's bold suggestion, Einstein in 1906 was able to give an explanation of Photoelectric action and, in fact, laid down the fundamental principle regarding the frequency of absorbed radiation and the amount of energy in the radiation

which passes within the matter. The most fruitful application of quantum hypothesis was made by Bohr in 1913 to give a picture of the constitution of atoms, and account for the characteristic radiation frequencies emitted by them. His explanation of the hydrogen spectrum and the calculation of the Rydberg constant was regarded as a capital success. Bohr assumed that atoms can exist only in certain discrete states in which the electrons within the atoms move in some definite orbits *without radiation* (in contradiction with Field theory). When a moving electron due to some cause jumps from one allowable orbit to another of, say, lower energy, the balance of energy is emitted as monochromatic radiation of frequency ν and energy $h\nu$, a rule of calculation known as Bohr's Frequency condition. The opposite process of electronic jump from an orbit of lower to higher energy corresponds to absorption of the corresponding frequency. Definite discontinuous states in which atoms may remain, and discontinuous processes are postulated, and intermediate steps are left quite blank. Frank and Hertz by their famous experiment on collision of slow moving electrons with gas atoms actually succeeded in demonstrating the reality of atomic states. Further development and systematization of line spectra was due to Sommerfeld and his pupils. To this Bohr himself added his brilliant contribution on the explanation of the Periodic classification of elements on the basis of his theory of constitution of atoms. A period of progress on this line followed till 1925, which may be called the intermediate stage between the Field theory and the New Mechanics. The net result obtained was a successful explanation of the spectra of one body problem (hydrogen like bodies), a formula for the fine structure of hydrogen and helium atoms, a formula for the X-ray spectra, the calculation of the Rydberg constant, and explanation of the Stark effect and the normal Zeemann effect. The calculations followed the classical method of Hamilton-Jacobi to which a quantum condition was engrafted. This *ad hoc* condition has often been likened to an additional constraint on the system. But this method was unable to get beyond the stage of a single body problem (hydrogen like atom) and, in fact, a careful discussion of the helium problem, which came out with results completely in disaccord with experience, showed the necessity for reorientation of the theory.

The Quantum Mechanics of Heisenberg originated with an attempt to work out the Principle of Correspondence to its logical end. Guided by the idea that only those quantities are to be introduced in the calculation, which are directly measurable, Heisenberg by an application of the Correspondence Principle was able to build up a Quantum dynamics and deduce the general spectroscopic laws which were previously obtained by co-ordination of a vast mass of empirical data. Two different ideas led to great development in this line. Firstly, there was

the idea of Uhlenbeck and Goudsmit, that the electron in the atom possesses in addition to its orbital motion also a spin motion, such that, while the orbital momentum is an integral multiple of $(h/2\pi)$ the spin momentum can be integral multiple of only $\frac{1}{2}(h/2\pi)$, and that to the latter also corresponds a *magnetic moment* of the electron of amount $(e/mc)(h/4\pi)$. The spectroscopic data for atoms were then classified in terms of four numbers, called quantum numbers, and perfect order in the spectroscopic laws was obtained after the discovery of the Exclusion Principle by Pauli, according to which no two electrons in the outer shell of an atom can have the same set of quantum numbers. The spin moment of the electron taken in conjunction with its orbital moment gives the correct way of splitting up of an atomic energy level in an external magnetic field. With the help of an empirical formula due to Landé, which was later on deduced also theoretically by Heisenberg on the basis of his Quantum Mechanics, complete explanation for the anomalous Zeemann Effect was obtained. The mathematical apparatus of the Quantum Mechanics is as different from that of the classical Field theory as can possibly be imagined. Instead of the method of differential equations, the Quantum Mechanics makes use of noncommutative algebra for all calculations. Two types of numbers are differentiated by Dirac: firstly, the ordinary scalar numbers called *c* numbers, and secondly, the quantum numbers or *q* numbers which are subject to a special method of calculation. These ideas very soon received further development and elucidation from the point of view of New Wave Mechanics introduced by Schrödinger.

The idea of de Broglie that with every material particle is to be associated a train of waves, called by him phase waves, served as starting point for Schrödinger's New Mechanics. Davison and Germer actually showed the existence of such waves, by allowing a stream of electrons to fall on a crystal and obtaining the Laue spots of the corresponding de Broglie waves. Schrödinger's method is that of differential equations and eigenwert problems, and at first sight appears to establish a connection with the continuous theory. The possible energies of the discrete states of the atom correspond to the eigenwerts of a differential equation which is really a wave equation. But the interpretation of the results, which has been developed later, presents a sharp contrast with the methods of continuous classical Physics. In the classical or Einsteinian Mechanics, the position and motion of a particle (or a set of particles) being known at any initial instant of time, the dynamical equations enable us to calculate its position at any other instant as function of time and of these initial values. Thus any characteristic of the motion of the particle at any subsequent moment can be *accurately* predicted. Moreover, all classical quantities are entirely determinate at every instant of time, and their values

can be exactly calculated. On the other hand, the dynamical variables describing the state of a particle in the New Wave Mechanics have, in general, no definite values, so that it is not always possible to rigorously locate the position of a particle at every instant. With every dynamical variable at any instant is to be associated only a number of *possible values* with a certain *probability* for every one of them. It is only these possible values and the probability for any one of these possible values that can be calculated by a differential equation of the form of wave equation. The new Mechanics does not claim to follow the evolution in time of the state of motion of the particle as classical Mechanics or the Field theory does. It occupies itself only with a statement of probability of dynamical quantities assuming definite values. For this reason, the wave phenomenon which is associated with the probable values of dynamical quantities has been called Probability wave. We may consider, for instance, the production of X-ray by collision of electrons with atoms as described before. In the wave mechanical treatment the colliding corpuscle is replaced by a system of de Broglie waves, and the charge in the atom is not concentrated but is extended as a cloud in the space where the wave phenomenon is supposed to take place. The question whether the collision between atom and electron is peripheral or central has no meaning as all individual processes are contained in the wave process. The whole problem is treated by a juxtaposition, according to certain mathematical rules, of the initial and final states, there being no supposition made regarding intermediate stages. The origin of radiation remains in obscurity. It is no longer a question of causality, but the physical reality is represented by a mathematical scheme which is able to explain most of the observational facts. In the face of this we have no other means but to accept the new mechanics, whose method is more philosophic than that of classical mechanics. We submit ourselves with resignation to this, 'as the question "why" of nature eludes us, leaving us to be satisfied only with "what it is" and "how", which are again to be determined by technical mathematics'.

This somewhat unusual mathematical scheme of the New Mechanics is quite in agreement with a certain peculiar feature of microphysics, first discovered by Heisenberg, and later on greatly developed by Bohr. It relates to the difficulty of simultaneous measurements of the position and momentum of an elementary particle by methods at our disposal. This Principle known as Uncertainty Principle of Heisenberg states, that if the position of a free electron, for instance, be measured with an uncertainty Δq , and its momentum at the same instant with uncertainty Δp , then the product of $|\Delta q|$ and $|\Delta p|$ is at least equal to Planck's constant h . This implies that a simultaneous accurate measurement of position and velocity of the electron

is on principle impossible. The reason for this lies in the fact that in the case of observations of microscopic phenomena, the measuring apparatus invariably disturbs the object to be observed *in an unknown manner*, making accurate measurements of the desired quantities impossible. The element of uncertainty makes it possible for us to speak only in terms of probability, and we are unable in this particular case to follow up the causal chain. This is often described as breakdown of Causal Principle. Since observation implies space-time representation of the particle, a strict working of Causal Principle, on account of the unknown disturbance by observational apparatus, is incompatible with space-time representation. The Causal Principle and space-time representation being thus mutually exclusive, Bohr has called the new Principle of Heisenberg the Principle of 'Complementarity'.

The new Principle of Uncertainty, due to its negation of Causality in a restricted sense, has in recent years been enthusiastically discussed by Philosophers, and old controversies on the subject have been revived. For precision of ideas it is necessary to put forth clearly in what sense Causality is used in Physical Sciences. In ordinary everyday life two *events* are said to be connected causally when one regularly follows the other. But the definition of 'regularity' leads to difficulty, as for a proof of absolute regularity no finite number of observations can be considered sufficient. There is, in fact, no hidden tie between the two events but any number of events can be interpolated between them. The so-called causal chain by which the events are supposed to be connected together, itself consists of events and it would be a mistake to consider the chain as reality. Causality, from the physical point of view, has a relationship with what is known as Law of Nature. The latter states what will be the particular event that belongs to a given cause as its effect, whereas Causality simply states that a definite cause will have a definite effect. The Laws are expressed as mathematical equations, and their failure will not certainly imply breakdown of Causality. Mathematical functions enable us to express a sequence of events by means of equations *if there be order in nature*, whereas Causality asserts *there is order in nature*. What Physical Science does when it is called upon to determine what is going to happen in future under certain conditions in the present, is to use mathematical functions for extrapolation and making prediction. It is only this possibility of making predictions by extrapolation and calculation which is meant when Physicists talk of the Causal Principle. Any further extension of ideas beyond this sense will have at least no physical significance.

There is some difference of opinion regarding indeterminateness and validity of Causal Principle among Physicists. It will be worth while to consider a brilliant analysis of the

Principle by Planck, one of the staunchest supporters of Causality. In the opinion of Planck an event is subject to Causality when it can be predicted with certainty. But since infallible prediction is not possible in a single case, we have either to give up Causality or modify its definition, which latter alternative has been adopted by the Physical Sciences. A physical event, after perception by our senses, or after measurement by our apparatus, is, so to say, translated from our world of senses to another ideal world, that is to a world of certain thought process, which is invented to escape from all uncertainties accompanying every measurement, and to help the formation of definite and exact ideas. By introducing this ideal world, the uncertainty in the prediction of a future incident is reduced to the uncertainties in the translation of an event from the world of senseperception to this ideal world, and vice versa. This applies equally to classical and quantum Physics. But in quantum Physics this relation between the world of senses and the ideal world is subjected to a further restriction by Planck's constant h , which can be understood from the point of view of causation only when the entire measuring apparatus and all phenomena connected with it, and the objects measured are taken as one system. But then there remains no possibility of measuring a physical object 'in itself', or of proving the law of Causation. So instead of modifying the object of observation or inventing an ideal world, we may imagine the existence of an ideal 'Geist' which can foretell future events, which really amounts to the assumption of the existence of a reasonable Order in Nature. On the whole, sums up Planck, the Causal Principle is neither true nor false. It is a sort of heuristic principle, a sort of pathfinder, which Science must make use of to obtain fruitful results.

Schrödinger's equation in nonrelativity form, where the probability is defined by a single wave function, succeeded in reobtaining all the previous results of the one-electron problem, and in addition built up a theory of Dispersion and Scattering. The so-called Selection Principle ultimately appeared as a property of normal functions. But the fine structure of alkali-like atoms, derived from a modified equation due to Klein and Gordon using a single wave function presented difficulty by duplicating the energy levels as regards their identification by quantum numbers and giving them wrong values. Besides, the equation in one wave function possessed no counterpart of the 'spin' phenomenon of Uhlenbeck and Goudsmit. Schrödinger's equation had one serious drawback. It possessed no invariance under Lorentz transformation, a property which all natural Laws are expected to satisfy. To bring into evidence the magnetic property of the electron, Pauli in 1927 associated two wave functions with the electron, determined by two equations. The two functions corresponded with the two values

of the spin $\pm (\hbar/4\pi)$ of the electron and its two possible magnetic moments of opposite signs. Pauli's model can be imagined as a charge with a small magnet attached to it. His equations (the operators) are invariant for only space transformations, as opposed to space-time Lorentz transformations. It was shown by Dirac that the simplest description of the electron, satisfying all conditions, is possible with four wave functions. The equations have Lorentz invariance—only the hyper-complex operator has this property, while the four wave functions are transformed in a definite manner *not* analogous to that of a vector. The classical approximation of the Dirac electron is a small electrified particle with a spin equal to that of the electron and possessing a magnetic moment. In the case of hydrogen atom, the sum of the orbital and spin moments is a constant, instead of only the orbital moment of the old quantum theory. Bohr has further explained why it would be impossible experimentally to measure the magnetic moment of the electron, or isolate the two portions of the total constant moment. For instance, in an attempt to determine the magnetic moment of the electron by magnetometer, the *uncertainty* in the magnetic field of the orbital motion of the electron due to the uncertainty of its position will be much larger than the magnetic field due to spin motion. Similar difficulty also arises in an attempt to separate spin moment from orbital moment. The essential features of Dirac's theory are a current density vector satisfying the conservation principle, and the existence of spin and magnetic moments of the electron (together with an imaginary electric moment for which no interpretation has yet been found). Dirac's equations have given us, on the whole, a correct theory of the fine structure and a satisfactory scattering formula due to Klein and Nishina. His mathematical scheme is, up to the present, the only one which fits in with the known behaviour of the electron and explains best the spectroscopic laws hitherto discovered.

A quantum theory of the radiation field has been developed hand in hand with the quantum theory of the electron. To Dirac himself we owe the theory of the emission and absorption of radiation by material particle, and of such non-periodic phenomena as collision which was also worked out previously by Born by a different method. Since then attempts have been made to build up a quantum electrodynamics by bringing into close relationship the electronic phenomena with those of the radiation field. The attempt by Heisenberg and Pauli is based on the development of a new Hamiltonian system for radiation field, and addition of the Hamiltonian for the particles and the interaction between the field and the particles. The radiation field is quantised and the radiant energy is supposed to exist as particles of energy associated with definite phases. The behaviour of the total system is then supposed to be described

by a wave phenomenon, from which conclusions are drawn by the usual arguments. The theory gives the Coulomb's law of interaction of two charged particles and also an expression for their magnetic interaction, which is identical with that obtainable from the classical theory. The self-energy of the electron has, however, an infinite value. A theory given by Dirac, in which the interaction between two electrons comes through the radiation field as the result of linking of the first electron with the field on the one hand, and of the field and the second electron on the other, suffers from exactly the same difficulty. Attempts made hitherto to avoid infinite self-energy in different ways have not met with any real success.

This brings us face to face with the difficulties of modern theoretical physics and the limitations of the current theory. We have seen that classical electrodynamics, in order to escape from the idea of infinite self-energy, postulated a definite radius for the electron. The quantum electrodynamics, as developed by the modern authors, has, however, borrowed from the classical theory the model of a point electron and has inevitably led to the classical conclusion of infinite self-energy. Klein and Jordan, starting from the nonrelativity Schrödinger equation succeeded, by manipulation of noncommutative variables in the Hamiltonian, in getting a zero value for self-energy. But it jumped up inexorably to infinite value when the relativity effect was considered, which means the reduction to zero value is not possible in an invariant manner. Oppenheimer, starting from the nonrelativistic equation was further able to show that the energy of interaction between radiation and free electron tends to become infinite. Similar result was also obtained by Rosenfeld for a harmonic oscillator. These difficulties suggest that we are as yet far from the exact theory of interaction between matter and energy.

The serious difficulty of Dirac's theory has been considered to be the existence of negative energy states for the electron, and its finite probability of transition to these states. Though these transitions are not very frequent still given sufficient time, one can imagine that all electrons have passed into these states of negative energy. Since negative energy states are contrary to experience, theory should give strictly zero probability for such transitions. Tam has shown that by quantising the radiation field and the material wave of the electron, it is possible to obtain the Klein Nishina formula on the basis of Dirac's equation. The negative energy states, however, play an important rôle in his calculation. A wrong formula is obtained when they are ignored. In the dispersion theory of Waller who deduced Heisenberg Kramer's formula from Dirac's equation, the negative energy states play exactly the same rôle in the second order approximation. From the point of view of correspondence principle, these states should not have entered

into the calculation at all, as classically they do not exist. Schrödinger has made an attempt to eliminate the negative energy states by breaking up every quantum-mechanical quantity into two parts, one of which he calls even and the other odd. The classical notion of the same quantity corresponds to the even part, while the odd portion, physically representable as very quick trembling motion of small amplitude, is due to the interaction between the positive and negative energy states. Schrödinger's plan is to omit from every quantity the corresponding odd part, as this modification forbids every transition from positive to negative energy states and vice versa. The effect of this is to introduce only small changes in theoretical results verified by spectroscopic observations, which are not measurable. So far the attempt, apart from the difficulty in the dispersion theory, is successful. But the success is attained by sacrificing the finest element in Dirac's theory, namely its relativity invariance. An attempt to avoid negative energy thus leads us back to the unsatisfactory non-invariant theory. The difficulty of negative energy has also been prominently emphasized in what is known as Klein's paradox. Klein has shown that if a stream of electrons with kinetic energy E falls on a barrier of potential discontinuity V such that, eV is greater than $m_0c^2 + E$, then some of the electrons will traverse the barrier and pass into the negative energy state. The proportion of transmitted electrons increases with velocity, and is approximately represented by the ratio $v : c$. This anomaly is not really a property of potential discontinuity, and as a matter of fact, Sauter by taking a potential slope was able to show, that the necessary and sufficient condition for transition to negative states is, that the potential must change by m_0c^2/e within a distance $(\hbar/4\pi m_0c)$. It is noteworthy that in the 'even' part of Keplerian operator in Schrödinger's sense, a variation of m_0c^2 in $\hbar/4\pi m_0c$ is not possible. This suggests that there is something in the field itself which behaves differently towards the even and odd parts of an operator, which are connected with the energies of the two signs. It can be shown that if the electron in the Hydrogen atom is inside a sphere of radius $\hbar/4\pi m_0c$, it is within the danger zone and has a probability of passing into the negative state, proportional to α^4 , where α is the fine structure constant. From these considerations it is to be concluded that the validity of Dirac's equation cannot be claimed for lengths which are smaller than the critical length $\hbar/4\pi m_0c = 1.6 \times 10^{-11} \text{ cm}$. The radius of the atomic nucleus being less than this critical length, it is evident that electrons within the nucleus, if they at all be there, cannot be subject to Dirac equation. But when m_0 in the denominator means mass of a proton, the critical value is diminished about 1800 times, so that the validity of Dirac equation for α particles in the nucleus becomes again possible. Gamow's theory of disintegration of

radioactive substances can be understood from this point of view. The critical distance contains c in the denominator, so that no difficulty arises in the nonrelativity case ($c \rightarrow \infty$), and the validity of Schrödinger equation extends up to zero length. The new mechanics of Dirac is thus expected to fail in the study of lengths of order less than (h/m_0c) or of time less than (h/m_0c^2) . The idea has often been expressed that these are the smallest possible length and time interval having physical significance. But this in addition to raising some quantum-mechanical difficulty pointed out by Landau and Peierls will also contradict the relativity principle.

Dirac has made an ingenious attempt to account for the negative states. He assumes that nearly all negative energy states are filled up in the sense of Pauli's exclusion principle, and any gap or 'hole' will appear to us as positive charge associated with positive mass like the proton, the positron not being known at that time. The electron with positive energy will have a probability of jumping into one of these 'holes' of negative energy state forming two light quanta. One can imagine such things are taking place in the stars. This idea has been strengthened and enthusiastically carried forward after the discovery of the positron. But Dirac, Oppenheimer and Tam have calculated the total amount of energy liberated by such process of conversion of matter into radiation and found it to be incredibly high. Recently Weisskopf has calculated the self-energy of the electron on the supposition of the 'hole' theory, and found the statical portion of the self-energy to be logarithmically infinite, whereas for Dirac's electron theory this divergence is linear. The electrodynamic portion of the self-energy diverges also. Recently Dirac has made another attempt to improve his 'hole' theory by breaking up the operators, corresponding to charge and current density for a system of electrons in which almost all negative energy states are filled up, into two parts and showing that for every external electromagnetic field one part, depending on the field and not on the state of the electrons is infinite, and the other part depending both on the field and on the electron state is finite and definite. Dirac suggests that the first part should be omitted, and the correct charge and current density be obtained by subtracting this infinite field dependent term from the total operator. The validity of the conservation principle of charge and current is not impaired by this, nor is the Lorentz invariance of the theory disturbed. This is no doubt a theoretical advance, but Furry and Oppenheimer point out that the result of this modification is that the divergence of the energymomentum tensor, constructed in the usual manner is not identical with Lorentz force, so that the principle of Conservation of energy and momentum breaks down. Moreover, the theory is unable to predict the reaction of the electron-proton-distribution to its

own field as the modified charge current density operator is defined only in the presence of external field. Nevertheless Furry and Oppenheimer point out that the validity of the theory will not be impaired in those cases where reaction of the electrons and protons to their own field is not involved, that is to say, no frequency of order (mc^3/e^2) occurs. The present electrodynamics is not expected to be applicable in questions involving this frequency or lengths of order e^2/mc^2 (radius of electron), and the paradoxes of the theory of the positron are connected with those of quantum electrodynamics.

In view of the difficulties of the New Mechanics discussed in the preceding paragraphs, the failure of the new electron theory within the atomic nucleus is not surprising. Bethe and Heitler have recently brought to light another phenomenon, where the theory appears to fail even outside the nucleus. The loss of energy of very fast electrons by emission of radiation in the nuclear electrostatic field has been measured by Anderson who found the loss for electrons with initial energy $300 \cdot 10^6$ e.v to be about $3 \cdot 5 \cdot 10^6$ v per cm. of lead. According to the theoretical calculations of Bethe and Heitler by Born's method of collision, this should be as high as $550 \cdot 10^6$ v per cm., which allowing for all corrections cannot be brought down below $150 \cdot 10^6$ v per cm., a result about four and half times too high. Generally, for initial energy greater than $137 mc^2$, this discrepancy will be expected. On the other hand, the twin birth of positive and negative electrons from a light quantum in the strong electrostatic field of the nucleus, studied by these authors by the same method receives wonderful justification in their results which are in exact agreement with recent measurements for γ rays of $3-10 mc^2$. It may be mentioned that the positive electron in their calculations is conceived as a Dirac 'hole', and the process of creation as the transition of an electron originally in the negative energy state to the state of positive energy with the absorption of radiation. The quantum electrodynamics which is yet to be formed should be able to explain this anomalous loss of energy by very fast electrons in the nuclear field.

These are difficulties connected with the formalism of the new theory and its applications. For lengths much greater than the critical length mentioned above the New Mechanics of Dirac is as yet known to work well. The mechanics of lengths and times less than their critical values discussed above is yet to come. It is, however, worth while to mention that the existing relativistic theory of Dirac is not cent. per cent. relativistic. The time in this theory has a privilege not enjoyed by other space co-ordinates. For instance, to every physical quantity corresponds a hermitian operator, but this hermitian character is defined only with regard to space, so that the definition of the quantum mechanical operator is not relativistically invariant. To calculate the mean value of a quantity, the corresponding

mean density, defined for space co-ordinates only, is integrated throughout the polydimensional space, ignoring the time. Such an operation cannot also be relativistically invariant. The method of New Mechanics requires a privileged position for time co-ordinate in another sense. Corresponding to the uncertainty relation $|\Delta x| |\Delta p_x| \geq h$ of Heisenberg, we should also expect the uncertainty $|\Delta W| |\Delta t| \geq h$. But this cannot be interpreted in the manner of the previous inequality, as the time t is used as a parameter in quantum mechanics, and its value is accurately known, and further W here should correspond to the Hamiltonian

operator which cannot be replaced by $\left(\hbar/2\pi i \frac{\partial}{\partial t} \right)$ corresponding

to the substitution $(\hbar/2\pi i \cdot \partial/\partial x)$ for p_x . Nevertheless, the latter uncertainty can be understood to mean that the measurement of energy of a particle by observation at a time with uncertainty Δt is subject to an uncertainty not less than $(h/\Delta t)$. This asymmetry between space and time appears to be inherent in Wave Mechanics in its present form.

Another difficulty of fundamental nature has been pointed out by Landau and Peierls. By applying the idea that only those quantities are to be introduced in microscopic mechanics which can be measured directly, or whose measurement is possible by some ideal experimental arrangements, to the relativistic theory and taking into account the uncertainty in energy of radiation due to acceleration, Landau and Peierls have arrived at the result, that for the process of the measurement of the electric field E , there is an uncertainty $\Delta E > \sqrt{\hbar c}/(c \Delta t)^2$. There is a corresponding relation for magnetic field. This shows that electric and magnetic fields are susceptible of definition only when they are static, and the time of measurement must be infinite. These authors further conclude that for fast moving electron no determination of position can exceed a limit (\hbar/mc) , and that the validity of Wave Mechanics is limited only to systems whose states vary but slowly. Their ultimate analysis even shows the idea of the photon to be somewhat illusory. These pessimistic results of Landau and Peierls still await explanation.

During recent years our knowledge of nuclear Physics has been considerably extended by experimenters. New particles of fundamental importance have been discovered, such as the neutron, an uncharged neutral corpuscle of nearly the same mass as proton, and the positron, the positive counterpart of the electron to which may be added diplogen, the hydrogen isotope of mass 2 with a nucleus of charge unity and mass 2 known as deuteron or diplogen. The bombardment of elements by fast α particles and neutrons is yielding new isotopes, and a mass of data of considerable importance is growing up. These results when properly systematized will certainly determine the future path of development of theoretical Physics. For the

present we shall note here certain facts on which attempts at construction of theories have been made. Experiments on collision of atomic nuclei with α particles have shown that Coulomb's law holds for considerably short distance from the nucleus which contains a sanctum where the fundamental particles, in simple or complex form are prevented from flying away from one another by a high potential wall. Behind this barrier within a potential hole, these particles exist in states about which no definite statement is as yet possible. However, the Coulomb field is modified from near the barrier, but the modified law is not yet known. The validity of Coulomb's law can be traced up to the distance 13×10^{-13} cm. for Aluminium nucleus and α particle but is certainly impaired at distances $6-8 \times 10^{-13}$ cm. In the production of neutrons by α bombardment, the nuclear charge is increased by 2 and mass by 3, a new nucleus is formed and a neutron is emitted. An analysis of the velocity distribution in neutrons shows that they are emitted in groups each one of which consists of a slower and a faster subgroup of definite or continuous velocities. The majority of the neutrons is found in the slower groups with which γ rays are also emitted. There are reasons to believe that the faster group represents an excited state of the nucleus which falls into a lower state representing slower group and the difference of energy is emitted as γ -ray. There has been difference of opinion regarding the mass of neutron which according to the latest determination of Chadwick is to be fixed at 1.0080, while according to Curie-Joliot it should be 1.010. With regard to the nature of the neutron all the three possibilities have been advocated. The first possibility is that the neutron is a fundamental particle. If the nucleus be built up of α particles, protons and neutrons as most physicists now believe, then the theory requires that the neutron should have a spin $\frac{1}{2}$. If the neutron be a complex of proton and electron, then since proton has also a spin $\frac{1}{2}$, the electron should have spin zero and moreover should obey Bose Einstein statistics which is contrary to the behaviour of free electrons. The third alternative that the proton itself is a complex of a neutron and a positron is possible if the mass of the proton be less than the sum of the masses of the neutron and positron. This is indeed supported by the latest determination of the mass of neutron by Chadwick but then the positron should have zero spin, and the production of light quanta by annihilation of electrons and positrons would be impossible. Of these three the second alternative, namely the neutron as a complex of proton and electron has been much discussed and used as a model of neutron for theoretically understanding the collision of neutrons with atomic nuclei. But the difficulties of this model are almost insurmountable. Firstly, the theory of the Hydrogen atom shows that there is no orbit lower than the first Bohr's orbit, that is to say, no such orbit

as $n=0$. The relativity wave equation with one wave function, known as Klein Gordon Equation, however, possesses a disposable level which can be attributed to neutron; but the corresponding energy is too low. On the other hand, as the binding energy in this case is greater than mc^2 , the distance between the electron and proton will be less than (h/mc) , and the velocity of electron on the classical orbit will be comparable to c . But for these critical cases the validity of Dirac equation is questionable. If the neutron is to have the constitution suggested, the problem can be solved only when the mechanics for intervals less than the critical intervals has been discovered. With regard to the other fundamental particle, namely positron, only its existence has been proved on photographic plates and no precision measurements are as yet available.

Several questions of fundamental importance have come to the forefront in the study of nuclear physics. In all calculations regarding conversion of one nucleus into another by bombardment and emission of particles, the conservation of energy and momentum is assumed, and the results have so far led to no contradiction. Equally remarkable is the application of Einstein's principle of the inertia of energy, first derived from the principle of Relativity, according to which the energy equivalent of a particle of definite mass is obtained by multiplying that mass by square of the velocity of light. The recent investigations of Anderson and Neddermeyer *quantitatively* support the theory that γ ray of definite energy can in the field of the atomic nucleus give birth to a pair of positive and negative electrons which fly off with the balance of energy left after the creation of their rest masses. As a matter of fact, without this principle no calculation in nuclear physics at the present stage seems to be possible. The β -disintegration of radioactive substances, however, supplies a case which has presented difficulty for the conservation principle. For β -disintegration the atomic number increases by one, and the emitted ray has a continuous velocity spectrum with an observed spread of kinetic energy amounting to some million electron volts. Ellis by measuring calorimetrically the energy made available by this process, has shown that this energy agrees with the mean energy of the spectrum, so that the idea that all electrons are primarily emitted with the same energy but lose varying amounts afterwards cannot be supported. The sharpness of γ ray levels and constancy in the rate of decay for α and β disintegrations, clearly indicate that the different atoms have nuclei which are exactly alike. The conclusion from these observations is the possibility of decomposition of similar atoms of a given parent substance into same end products, with liberation of varying amounts of energy. This obviously is a violation of the energy principle in individual elementary process, a point considerably stressed upon by Bohr. It has further been pointed out by him

that the hypothesis, that there is no violation from the statistical point of view—the average energy liberated in the decomposition of any such atoms being equal to the difference between the energies of the initial and final substances, is still unable to save the energy principle. For if there be finite probability for electrons of different energies to re-enter the nuclei and rebuild the parent substance, an actual net increase in energy can be obtained, by first allowing the decomposition to take place and then rebuilding the original nuclei by taking electrons having lower energy than the average of those spontaneously emitted. But this theory of nonconservation is again attended with further difficulty. It has been pointed out by Landau that nonconservation would mean the failure of Gauss's law (according to which the mass inside a closed space is uniquely determined by the distribution of gravitational field on the surface), and along with it a modification of the law of gravitation. Moreover, the existence of the sharp maximum in the β -spectrum cannot be understood for nonconservation, in which case a Maxwellian distribution is to be expected. For these reasons an attempt has been made by Pauli to save the principle of conservation by assuming that neutral uncharged particles of extremely small mass called neutrino are emitted along with β -ray, which escape observation and carry away the balance of energy. But there is as yet no fact to support this theory. The explanation of continuous β -spectrum has yet to be found.

These are some of the difficulties which the quantum theory has to solve. The success of the theory lies in the correct description of facts and its ability to make prediction with reasonable accuracy. We have previously noted the attitude of the New Mechanics towards what we formerly used to call understanding nature. We have to be satisfied only with a correct description and not to be troubled about 'why'. The old duality of light as wave and energy corpuscle is extended to matter. The mathematical apparatus has been so fashioned that the observational facts can once be interpreted in terms of waves and again as material particles. This is the central idea of the New Mechanics. It may be hoped that in future deeper insight into some of the fundamental facts and hypotheses of quantum theory will be gained. For instance, the mechanism of Bohr's frequency condition, the secret of Pauli's principle, complete harmony between wave and quantum conceptions of radiation, the interaction between matter and radiation, the existence of fundamental particles such as electrons, positrons, neutrons, protons and similar other questions will have to be answered before our 'understanding of nature' can bring us any real satisfaction. These are undoubtedly problems of theoretical physics in the further stage of its development.

The attitude taken by Physicists towards the fundamental problem of Matter and Field may be analysed thus. A small

number of eminent philosophers, amongst whom is to be counted Einstein, believe that the entire scheme of nature is adequately contained in a Field theory. The material particles, such as electrons, protons, etc. have no real independent existence, but are only peculiarities of the Field. The gravitational and electromagnetic phenomena are components of one more complete system in which these two are organically connected. The set of partial differential equations describing this entire scheme should be, unlike Maxwell's equations which are good approximations for only weak and moderate fields, nonlinear in character. Their singularities should explain why there are such peculiar particles as electrons, positrons, protons, etc. with this definite amount of masses and charges in nature, and also why energy appears to exist as quanta, which behave in such unorthodox nonclassical manner so beautifully described by the present-day New Mechanics. The search for such laws has led to different Unitary Field theories by several mathematicians, none of which, however, fulfils the aim. As yet they may be regarded as only first steps. The Relativity theory of Einstein fused time and space into one single four-dimensional manifold in which gravitational phenomenon is supposed to play its rôle. The formalism of the theory was found to be contained in the Riemannian geometry of the four-dimensional manifold with certain restrictions. In the classical theory, the space is regarded as Euclidean. In this space a gravitational potential is introduced which is determined by the distribution of matter but does not in any way influence the property of the space. In Einstein's scheme new gravitational (potential) functions 10 in number, are introduced whose properties entirely determine the property of the space. These functions are connected with the distribution of matter in space and its dynamical condition. The equality of gravitational and inertial masses mentioned before is a necessary consequence of the Principle of Equivalence according to which a gravitational field can be *locally* made to disappear by choosing a suitably accelerated system of reference in which all measurements can be made in strict accordance with Euclidean geometry and in which there will be only inertia and no gravitation. Inertia and gravitation are one and the same property of matter, the difference lies only in our point of view. The electromagnetic phenomena in Einstein's theory are on a somewhat different footing with regard to space, and are not directly connected with gravitational phenomena. A scheme in which the structure of space depends simultaneously on gravitational and electromagnetic potentials was constructed by Weyl, but had no success from the physical point of view. A more general theory by Eddington on the same line had the same defect. A more attractive unitary theory unifying gravitation and electricity was given by Kaluza, and later on improved upon by Klein. But this unification was made with a space structure of five

dimensions. The fifth dimension is physically inexplicable as space-time is apparently four-dimensional; moreover the theory introduces an extra quantity over those required by empirical data, which cannot be interpreted, and above all gives no explanation why e/m for an electron should be constant. Einstein in collaboration with Mayer has done extensive work on the basis of Kaluza's theory to erect the structure of unitary theory in four-dimensional space. Veblen has also recently reset this theory with the mathematical apparatus of projective differential geometry, developed within the last few years. But these theories all fail on the side of material particle. Physically, the most interesting theory was given by Mie whose very elegantly built mathematical scheme required for ultimate success the discovery of a suitable World function. But while his theory showed the possibility of the existence of such a particle as electron, it gave an absolute significance to the electromagnetic potential, which is contrary to experience. The question remains still open and hangs on the discovery of a suitable World function. An attempt was made by Einstein himself by modifying his field equations in the sense, that gravitational forces were made responsible for holding together the parts of the charged particle. The gravitational forces thus replaced the non-Maxwellian forces and Poincaré's pressure of the classical theory. In fact, three-fourths of the energy of the particle according to this theory was electromagnetic and one-fourth gravitational in character. The latter fraction corresponds exactly to the energy of nonelectromagnetic origin in Lorentz electron. But the theory predicted the existence of electric particles with all possible charges, in contradiction with experience. The newest venture in this line is that of Born and Infeld who have in a way revived Mie's theory and have written down a Lagrangian function from the idea, that it should provide for the existence of an upper limit to the purely electric field, just as velocity has an upper limit in the velocity of light. The field equations obtained from a variation principle, resemble those of Maxwell in a polarisable medium of which the dielectric constant and magnetic susceptibility are dependent on the field components. It is shown that conservation principles apply and the existence of a point electron is possible with finite energy (thus avoiding the vexed question of infinite self-energy). In external field the motion of this electron is of the Lorentz type. The point electron can also be pictured consistently as a free charge with spatial distribution. The value of the limiting absolute field is enormously high, which ensures the validity of Maxwell's equations except where the inner structure of electron is concerned. Towards extraneous vibrating fields of wave lengths small compared to electronic radius, the electron reacts in such a manner that the effective charge diminishes with wave length producing weaker interaction. Thus far the success of

the new theory is remarkable and the development of the theory to the quantum stage is awaited with great expectation.

As against these attempts at a Field theory there is the opinion of a large number of theorists that the quantum principles cannot be brought into harmony with a continuous Field theory, and the ultimate object can be attained only by pursuing the discontinuous quantum idea and building up a successful quantum electrodynamics. It is then advisable to regard material particles as separate entities, different from the Field and, in fact, as sources of the Field. The main problem is to find the law of interaction between the field and the particles. It is pointed out that though it will certainly be desirable to give up the idea of action at distance, it has not so far been possible to formulate the quantum mechanics as the propagation of an action. This would imply in addition to the difficulties already discussed, the introduction of many 'times' a time for each particle, the relation amongst which is very obscure, and even a modification of the notions of space and time in microscopic physics. The future alone will decide which of these two ideas is going to give us the key to the secret of Nature.

Section of Mathematics and Physics.

Abstracts.

1. Absorption spectra of soap solutions.

L. D. MAHAJAN, Patiala.

The visible and ultra-violet absorption spectra of soap solutions, especially of sodium oleate solution of N/1000 strength is studied in detail, with the Adam Hilger's spectrograph E₂. A number of photographs of the absorption spectra of the soap solution of various thicknesses varying from 5 mm. to 100 mm., with the help of Baly's tube are taken. It is observed that there is a general absorption of ultra-violet rays. The absorption limits are studied with the help of A. Hilger's micrometer scale and the Hartmann's formula. It is found that the absorption starts from about wave-length 4000 Å in these solutions.

2. Intensities of the lines in mercury spectrum.

N. B. BHATT, Bangalore.

This investigation was undertaken to note the changes in the spectra of mercury vapour excited at low pressure by high frequency oscillations of different wave-lengths. A Hartley oscillator employing a Mullard D O 40 transmitting valve was built to give enough power for wave-lengths above 20 meters. A magnetron oscillator described by the author elsewhere was used for wave-lengths between one meter and 20 meters. It was found that as the frequency of the oscillations diminishes, the relative intensity of the line λ 4797 Å increases.

The changes in the relative intensities of the individual lines between the arc and the high frequency spectra of mercury vapour were found to be the same as observed by Tolansky (*Proc. Phys. Soc.*, 42, 556, 1930; 43, 545, 1931).

The Tesla discharge in mercury has also been studied and the general nature of the whole spectrum is the same as found by L. & E. Bloch. (*Comp. Rend.*, 176, 835, 1923). It is interesting to observe that the relative intensity of the line λ 3984 Å is the greatest in the Tesla excitation and smallest in the high frequency excitation.

A thin film of mercury is found to adhere to the walls of the discharge tube and shows beautiful colours both in scattered and reflected light. The film does not vanish even if the tube is heated to dull red heat.

3. Spark lines of bromine.

MELA RAM, Lahore.

The spectrum of bromine was excited by electrodeless discharge and measured by a one-metre vacuum grating. The range of observations extended from λ 1250 to 2350. In all about 35 new lines have been tabulated.

4. Intensities in the violet system of cynogen.

N. R. TAWDE, Bombay.

Quantitative estimation of intensities in the bands of this system has revealed that the maxima fall on a narrow Condon parabola which is to

be expected according to the values of constants for the electronic energy levels. Examination of vibrational energy shows some approach to Boltzmann distribution under arc conditions.

5. Some interpretations of band spectroscopic results.

N. R. TAWDE, Bombay.

The vibrational and rotational levels of nitrogen molecule have been correlated and the results examined in the light of Rydberg's general conclusions on some other molecules.

6. Fine structure of iodine lines.

P. N. KALIA, Lahore.

The source of light was a tube filled with iodine at a pressure below 0.5 mm. of Hg, round which an electrodeless ring discharge was passed. The following lines showed hyperfine structures as observed with Lummer-Gehrcke glass plate :—

6074.9, 5774.8, 5738.5, 5710.4, 5690.9, 5678.1, 5496.9, 5464.6,
5405.3, 5161.2, 4676.5, 4632.4, 4473.5, 4464.4, 4444.8.

7. An investigation of the fine structure of the spectrum lines of manganese in the visible region. (Part I.)

WALI MOHAMMAD, Lucknow.

All the important lines of manganese arc in vacuum have been investigated and their hyperfine structure found by means of large-sized quartz Lummer-Gehrcke plates and a Hilger's 3-metre type quartz spectrograph. A specially constructed vacuum arc lamp as used in the previous investigations of the author was used as the source of light. Two quartz Lummer plates were used separately and the results compared. The values found have been compared with those obtained by other investigators like Janicki, Wali Mohammad, White, and Ritschl.

8. Hyperfine structure of bromine lines.

MELA RAM, Lahore.

The arc and spark lines of bromine in the visible region were excited by electrodeless discharge, and observed with a Lummer plate in conjunction with a constant deviation spectrograph. Fine structures appear to be singularly absent.

9. The surface-force theory of crystal rectification.

S. R. KHASTGIR, Dacca.

A theory of crystal rectification is developed in this paper. The crystal detectors have been classified into two groups: (1) Crystals having centres of symmetry and (2) crystals having no such symmetry. In the symmetrical crystals we observe rectification which is associated with point-contacts. In the second group of crystals, besides this 'point' rectification, there is an additional amount of rectification due to 'asymmetric' conduction in such crystals. The rectification in the symmetrical crystals has been explained by a theory based on the existence of an electrostatic force on the surface of such crystals.

Of the two features in the current-voltage characteristic curves, viz. (1) the asymmetry and (2) curvature, the first has been explained in the case of symmetrical crystals in terms of this electrostatic surface-force. The non-linear nature of the characteristic curve has been attributed to the Joulean heating at the contact point and the consequent decrease of contact resistance and also to the effect of strain on the crystal.

The following experimental facts are explicable according to the author's surface-force theory :—

- (1) The necessity of a small contact area for rectification in the case of symmetrical crystals.
- (2) Rectification observed in the case of symmetrical crystals in contact with crystals of the same composition.
- (3) Decrease in rectification on heating the crystals.
- (4) Decrease in rectification on heating the junction in the case of symmetrical crystals.
- (5) Decrease in rectification on exposure to ultra-violet light and X-rays.

10. Investigations on the rectification of alternating current by crystals.

S. R. KHASTGIR and A. K. DAS GUPTA, Dacca.

The important experimental results are given below :—

- (1) The rectification effects do not seem to have any connection with the contact potential.
- (2) Experiments with the symmetrical crystals in contact with the crystals of the same composition have shown rectification effects which are small for many contact points and moderately large for many others.
- (3) All the crystals have shown decrease in rectification when the temperature has been raised to 100°C.
- (4) The effect of heating the contact point has been in general to decrease rectification in the case of the symmetrical crystals. In carborundum, zincite and silicon, there has been no effect.
- (5) The thermo-electric current on heating the junction between the silver point and each of the crystals has been found to flow invariably from the crystal to the point. The rectified current, however, has been in the same direction in some combinations and in the opposite direction in others.
- (6) The effect of ultra-violet light on rectification has been found to be extremely small.
- (7) The effect of X-rays on rectification has been to reduce it considerably.

In carborundum, in a few cases, there has been a change in the sign of rectification.

The X-ray effect has been found to persist for several hours.

11. The atomic arrangements in anthraquinone crystals.

K. BANERJEE, Dacca.

The axial length c of anthraquinone is too small to contain the thickness of two molecules. The ab plane is an ordinary plane of symmetry and not a glide plane. The anthraquinone molecule does not have a plane of symmetry. So the only arrangement that is possible is that all the benzene rings in a molecule are in one plane that is parallel to the ab plane and the oxygen atoms as well as the hydrogen atoms of adjacent molecules are on tops of one another. Structure factors calculated from the arrangement obtained in that way are in agreement with those from the estimated intensities.

12. Space-group of anthraquinone crystals.

B. C. GUHA and K. BANERJEE, Dacca.

Rotation photographs of anthraquinone crystals about a , b and c axes gave the following values for the axial lengths :

$$\begin{aligned} a &= 19.7 \text{ \AA} \\ b &= 24.6 \text{ \AA} \\ c &= 3.95 \text{ \AA} \end{aligned}$$

Oscillation photographs at ranges of 10° about the b and c axes were taken for all angles. The spots were indexed by Bernal's method. Systematic 'Ausloschungen' were found for $h+k$ odd only. The crystals were goniometrically studied and found to belong to the orthorhombic bipyramidal class agreeing with existing data. So the space-group is $D_{2h}^{24}mmu$ (V_h^{19} of Schönflies).

13. Raman spectrum of arsenious acid.

BALMUKAND ANAND and KASTURI LALL, Lahore.

The Raman spectrum of arsenious acid has been investigated by employing light from four reflecting mercury arcs. The following infra-red frequencies were observed: 1914 cm.^{-1} and 2196 cm.^{-1} .

14. Evidence of positrons from bismuth.

H. P. DE and S. D. CHATTERJEE, Calcutta.

This paper gives an account of an attempt to observe the emission of positrons from a block of bismuth due to the interaction of γ -rays and neutrons with the latter. The source of radiation was a glass tube containing 2 mgrms. of radium bromide to which a certain amount of beryllium oxide was added. This radium tube was placed within a massive block of lead provided with a narrow axial hole in order to confine the radiations emitted in a particular direction. A rectangular block of bismuth about 0.6 cm. thick was placed inside the Wilson chamber along its edge in front of the hole in the lead block. A uniform magnetic field of about 1000 gauss was maintained within the expansion chamber.

It was found that the positrons of different energy values were emitted from the bismuth block (energies ranging from $3 \times 10^5 - 10^6$ electron volts). From the known absorption data (Thibaud, *Phys. Rev.*, 1934) for the positrons it was inferred that the origin of the positrons was in the bismuth block and not in the material lying between the source of radiation and the former. The origin of the positrons can be attributed to be due to the interaction of either hard γ -rays or the neutrons with the bismuth nuclei. The difference in the energy content of the positrons might be due to various reasons, one of them being the fact that the particles were emitted from the different layers of that bismuth block.

15. Induced radioactivity and nuclear spin.

D. S. KOTIARI, Delhi.

The ideas of Fermi and Gamow are extended to the case of induced radioactivity discovered by the Jolcots. If we plot the values of the decay constants for the artificially produced radioactive bodies and the maximum energy limit of their respective β^+ spectrum on the same diagram as that of Sargent (*Proc. Roy. Soc.*, Vol. 139, 1933), we find that, for example—

- (i) radio-silicon falls towards the left (low energy for the same decay constant) of the Gamow line $\Delta j=0$ for natural β -ray bodies,
- (ii) radio-phosphorous falls towards the left of the Gamow line $\Delta j=1$,

and further their distance from the respective Gamow line is discussed and this immediately leads to a value of the neutron mass = 1.0080, in excellent agreement with Chadwick's recent results (*Nature*, 18th August, 1934).

The result above mentioned, that for radio-silicon disintegration $\Delta j=0$ and for radio-phosphorous disintegration $\Delta j=1$, is found to be quite compatible and is in fact very satisfactory with the spin values

that we would assign from our general ideas based on a study of the available results on nuclear spins deduced from band spectra and hyperfine structure. The case of other induced radioactive elements is also discussed.

16. A perturbation in the 31-electron system of selenium.

K. R. RAO and S. G. KRISHNAMURTY, Waltair.

The analysis of the spectrum of selenium has led to the detection of an interesting intensity anomaly in the member $4p^4S-5s^4p$ involving the ground levels of Se II. It seems to be due to a perturbation arising from the mutual interaction of adjacent spectral terms.

17. 32-Electron system of selenium.

K. R. RAO and S. G. KRISHNAMURTY, Waltair.

A further study of the spectrum of selenium has led to the discovery of many additional levels assignable to the doubly ionized atom, arising chiefly from the $5s$, $4d$ and higher electron configurations. In the light of these data, the question of the limits to which the component levels tend to converge has been discussed.

18. Tele-olefaction.

B. D. VIRMANI, Bombay.

The author in this paper announces a new discovery of certain 'Electro-olefactorially Active' substances and describes their application to the transmission and reception of smell by electricity either on wires or by wireless. Very interesting new phenomena have been unearthed and sweet fragrance of several flowers and perfumes has been successfully transmitted by wireless up to a distance of about 65 miles. The Electro-olefactory Cell is much more sensitive than the human nose, it will detect the smell emitted by the burning of a small rag 100 yards away and will operate at once any automatic fire control apparatus.

19. Supersensitive superpower thermionic valve.

B. D. VIRMANI, Bombay.

In this paper the author describes his invention of three new types of thermionic valves having a sensitivity equal to that of the best existing radio frequency pentode, but capable of controlling a current of $\frac{1}{2}$ to 6 amperes at 250 volts.

20. Complete elimination of fading in wireless receivers.

B. D. VIRMANI, Bombay.

The present method of automatic volume control by automatically varying the grid bias of the variable mu valves for overcoming fading in wireless receivers has so serious limitations that at present it is impossible to overcome fading entirely. The author has attacked the problem of fading from a different angle and has invented a system, described in this paper, with which, it is claimed, that fading can be entirely eliminated.

21. Automatic heterodyne.

B. D. VIRMANI, Bombay.

In superheterodyne receivers, the frequency of the incoming signal is converted to a fixed low frequency (Intermediate Frequency) by beating with the locally generated oscillations. The oscillator has, therefore, to

be tuned for every station received, and consequently, complications are introduced in the design of oscillator inductances and ganging of variable condensers, which also affects the price of a wireless receiver.

It has also been shown that extremely quick fading lasting for a micro-second or so is due to frequency drifts. The tuning of the present-day receivers is sufficiently broad that they are capable of admitting a signal slightly off the theoretical resonance point, but the signal is still missed as the local heterodyne oscillator fails to generate a new frequency so as to produce the fixed intermediate frequency in order to make the signal stay in the receiver. When receivers are employed on commercial telegraph service, where each and every word is paid for, it is extremely important that nothing should be missed. The author has consequently worked out an automatic heterodyne system, which does not require conventional constant tuning, automatically looks after frequency drifts, takes less space in a receiver and at the same time reduces its cost.

22. On the radiation resistance of parallel wire high frequency transmission lines.

S. S. BANERJEE, Benares.

In the investigation described here the effect of bends on the radiation resistance of transmission lines has been studied both theoretically and experimentally. Two types of bends have been discussed; first, when the pair of wires is bent in the plane containing the wires and second when it is bent in a plane the perpendicular to which is parallel to the shortest distance between the wires. For the first case the radiation resistance has been found to increase with the decrease of the angle between the bent arms. The increase is rapid for angles less than 90° . For the second case the corresponding increase in resistance is extremely small. It is therefore concluded that to minimize radiation losses, unavoidable bends in long transmission lines should always be such that the perpendicular to the plane in which the bend occurs is parallel to the shortest distance between the wires.

As a preliminary to the above investigation the variation in the radiation resistance of straight parallel wire system for various separations between the two wires has also been studied. The radiation is inappreciable for separations below $\lambda/20$; for separations beyond this value the radiation resistance increases rapidly. The investigation was undertaken at the suggestion of Prof. S. K. Mitra.

23. Measurement of the angles of incidence of downcoming rays of long distance short wave signals received at Calcutta.

S. K. MITRA and A. C. GHOSH, Calcutta.

A knowledge of the angles at which short wave downcoming rays in long distance wireless transmission meet the surface of the earth is very important in understanding the nature of the ray paths of the waves through the ionosphere. Investigation in this line has, for this reason, been carried out in America and in England by Fris, Eckersley, Hollingworth, and others. In India no such investigation has been made till now by any one, though the geographical position of this country and the local peculiarities of the structure of the ionosphere above it must profoundly affect the course of the wireless rays. Recognizing the importance of such investigation we have recently made arrangements for measurement of the angles of incidence of downcoming wireless rays at Calcutta. The method adopted for the purpose is a modification of that used by the Radio Research Board to suit local conditions. Briefly, it consists in erecting two parallel horizontal aeriels, the distance separating

the two being about two wave-lengths. The e.m.f.'s developed in these two aerials by the downcoming waves, after suitable amplification, are applied to the two pairs of plates of a cathode ray oscillograph. The resulting elliptic trace on the fluorescent screen of the oscillograph gives the phase difference of the two e.m.f.'s. The angle of incidence can then be directly deduced. Report on the measurements and the results obtained will be presented to the congress.

24. Recording wireless echoes at the transmitting stations.

S. K. MITRA and P. SYAM, Calcutta.

In the study of the ionosphere by the echo method necessity is often felt of locating the receiver not far removed from the transmitter. The quick changes of wave-length necessary for many measurements may then be made by a single observer or more easily by two observers, one at the receiver and the other at the transmitter who are in direct communication with one another. There are, however, two difficulties for which the receiver cannot be placed near the transmitter. One of the difficulties is the absorption of the echo by the larger and the more efficient transmitting aerial (as compared with the small receiving frame aerial). This has been discussed by Mitra and Rakshit (*Nature*, 131, p. 657, May 6, 1933) and a method of overcoming the same has also been described. The other difficulty is the paralyzing of the receiver by the strong electric shock due to the direct signal pulses coming from the transmitter. The effect of the shock lasts for several milli-seconds even after the direct signal is over and renders the set insensitive for receiving the echoes when they arrive after a length of time of the same order. Various methods have been adopted by various workers to obviate this difficulty. A simple method developed by us, for minimizing this effect is described here. The receiver with the recording system is removed to a distance of a few metres from the transmitter proper. The grid of the first valve of the receiver is excited simultaneously with a frame aerial which receives energy by radiation from the transmitter (as well as the echoes), and by a small shielded coil which receives energy directly by means of parallel wire transmission lines from the induction field of the transmitter. By proper adjustments of the phases and strengths of the two signals, the resultant electric shock on the grid of the first valve is made very small for direct signal. The grid is thus prevented from being paralyzed.

25. Dielectric properties of some vegetable oils.

P. Y. DESHPANDE and G. R. PARANJPE, Bombay.

The method of solution is used to establish the dipole character and to determine the values for the polarizations and electric moments of the molecules of castor oil, olive oil, sesame oil, and coconut oil.

It is found that, though at higher concentrations the molecular association is effective, in very dilute solutions the molecules of these oils are more or less free from association and hence the Debye Equation for dilute solutions of polar substances in non-polar solvents could be applied. Experiments on very dilute solutions of these oils in benzene have given fairly reasonable values for their electric moments which are in this case 3.678×10^{-18} ; 3.030×10^{-18} ; 2.914×10^{-18} ; and 2.821×10^{-18} for castor oil, olive oil, sesame oil, and coconut oil respectively.

26. The effect of magnetic field on chemical reactions.

K. N. MATHUR, Lucknow.

The effect of magnetic field on a number of chemical reactions was studied in detail by Bhatnagar, Mathur, and Kapur [*Phil. Mag.*, viii, 457 (1929)]. As a result of their investigations they suggested the empirical

rule that those reactions in which the sum of the molecular magnetic susceptibilities increased during the course of reaction were accelerated by magnetic field and conversely those in which it diminished were retarded. Several other chemical reactions have now been examined and are seen to conform to the above general rule. In particular, several chemical reactions taking place in photographic practice with various materials have been examined under superposed fields. These throw valuable light on the theory of photographic sensitivity.

27. Mobilities of ions in flames.

NAZIR AHMED, Lahore.

The mobilities of ions in salted flames have been investigated by the observation on Hall-Effect. A large flat flame was formed by putting a number of pyrex-glass burners in a row and carefully regulated supplies of sprayed salts were introduced in the steady air-kerosine gas flame. Equipotential points in the flame were located by a pair of platinum wire electrodes. Magnetic fields varying from 1000 to 5000 gauss were employed and at all values steady deflections were obtained. The sum of the mobilities of positive and negative ions for NaCl, KCl, Na₂CO₃, etc. etc. ranged very nearly about 2600 cms./sec. cm./volt. This is slightly smaller than the values observed by other methods, but it shows that the main current is carried by electrons.

28. Technique for making Schumann plates under tropical conditions.

P. K. KICHLU, Lahore.

As a result of experience gained in the preparation of Schumann plates during the last two years, a modified technique has been developed for successful plates with long life and sensitivity under tropical conditions.

29. Vapour pressure of platinum.

PANNA LAL, Lahore.

Vapour pressure of platinum at different temperatures has been determined by finding out the decrease in weight produced per unit length of a platinum wire heated electrically at pressures below 10 mm. The variation of the rate of evaporation with temperature is found to agree excellently with the thermodynamic relations deduced from Clausius-Clapeyron equation. The value of the chemical constant as determined from the vapour pressure equation of Nernst, viz. :

$$\log p = -\frac{\lambda_0}{4.571 T} + 1.75 \log T + C$$

comes out as 2.5, which is more in accordance with the theoretical value given by Nernst, than others obtained hitherto by these methods.

30. Effect of light on the surface tension of soap solutions. Part II.

L. D. MAHAJAN, Patiala.

In this paper, the effects of visible and ultra-violet rays, and the concentration of the soap in the solution on the fall of its surface tension are studied in detail. It is observed that the magnitude of fall of surface tension is maximum in the violet and the ultra-violet regions. It increases with the dilution of the soap solution up to a certain limit. But beyond this limit, there is a decrease of magnitude for when the dilution becomes

very high, say, infinity, the solution is mere water, the surface tension of which is not effected by light.

Moreover, the study of absorption spectra of the soap solution shows that there is an enormous absorption in the ultra-violet region and starts from about 4000 Å. Hence, it is concluded that the fall of surface tension is due to some chemical change brought about by the action of violet and ultra-violet rays which are absorbed by the solution.

31. Application of performance test in seasonal forecasting of rainfall in India.

S. R. SAVOUR, Poona.

The performance test which was first clearly formulated by C. W. B. Normand in June, 1931, and published by him in June, 1932, can only be applied when data, other than those used in selecting a factor, are available. This means that in the case of factors selected for seasonal forecasts, the data used for the performance test are those that are *subsequent* to the date of selection. Thus the number of data in each case lies between 11 and 14 or thereabouts. The smallness of these numbers gives rise to big probable errors for the test C.C.'s (correlation coefficient) thus making it difficult to draw any definite conclusions regarding the significance of these factors. A method has been given in this paper which enables us to overcome the defect mentioned above.

The test C.C. (correlation coefficient) is a C.C. in which there is no bias due to selection at all. The old C.C., by which the selection was made, is, however, influenced by selection. The method given in this paper enables us to obtain from the old C.C., a value in which the bias due to selection has been eliminated. This value and the corresponding test C.C. will now enable us to say more definitely whether the factor can be considered significant or not.

32. Aerial waves produced by meteorites.

S. K. BANERJI, Bombay.

A meteorite usually enters the earth's atmosphere with a velocity considerably greater than that of sound. A meteorite in flight will consequently produce the usual shock waves. A second type of impulsive waves will be produced if the meteorite reaches the ground and suffers a sudden destruction of velocity. The aerial waves produced by the great Siberian meteorite of June 30, 1908, have received considerable attention in recent years but it does not appear that the two types of waves have been correctly identified. It is possible to obtain theoretical expressions for the two types of waves and determine their properties. For instance, the waves produced by a sudden destruction of velocity will be of the type

$$\phi = \frac{Ua^3}{2\sqrt{2}} \left[\frac{\partial}{\partial r} \left\{ \frac{e^{-(ct+a-r)a}}{r} \cos \left(\frac{ct+a-r}{a} - \frac{1}{4}\pi \right) \right\} \cos \theta \right. \\ \left. + \frac{\partial}{\partial r'} \left\{ \frac{e^{-(ct+a-r')a}}{r'} \cos \left(\frac{ct+a-r'}{a} - \frac{1}{4}\pi \right) \right\} \cos \theta' \right], \quad (t > 0, r < ct+a),$$

where c is the velocity of sound, U the velocity of the meteor, a its radius, r, θ and r', θ' co-ordinates measured in a certain way from the centre of the meteorite and its image-point with respect to the earth's surface. The expression shows that $2\pi a/c$ is the period of the waves. From observational evidence, the Siberian meteorite may be considered to have roughly a radius of 10 KM.; the period of waves is therefore 3 mins. Theory shows that the shock waves will have smaller periods. As the meteor moves faster than sound, the impulsive waves will ordinarily

reach a distant station earlier than the shock waves. It appears that Whipple has mistaken one wave with the other in the barograph records of the Siberian meteor. The first part of the disturbance produced in the barograms were apparently due to the impact of the meteor with the ground and the sudden oscillations of smaller periods in the latter part to shock waves. The estimate of energy of this meteor made by Whipple and Astapowitch appears to be an under-estimate.

33. The applications of interferometry to the study of lapse-rates of temperature and convective or conductive processes very near hot surfaces.

L. A. RAMDAS and M. K. PARANJPE, Poona.

The present paper is in continuation of earlier studies on surface convection by the senior author. The interferometric method of investigating conditions above and below a hot surface has proved extremely useful in elucidating these phenomena. The same method has also been successfully used in studying what happens above an evaporating surface.

34. The rôle of radiation and turbulence in nocturnal cooling.

L. A. RAMDAS, Poona.

During winter owing to radiation cooling after sunset the air layers near the ground stratify. The rate of cooling is very rapid during the first half an hour after sunset during calm days, but on days with winds the slope of the temperature-time curve is less pronounced. Thus radiation and turbulence act in opposite directions. A study of stratification versus air movement has been made, utilizing the records of last winter.

35. On the genesis, structure, and movement of the Indian monsoon cyclones.

S. C. ROY, Colaba.

The asymmetric distribution of rainfall and other weather characteristics around cyclones of the Indian seas is not compatible with the postulate that tropical cyclones are generated merely by the latent instability of a uniform air mass containing an abundant supply of moisture. The seasonal distribution of cyclones and the regional sequence of their origin in the Indian seas lead invariably to the conclusion that the mechanics of their growth should be sought in the interaction of two main air masses—one of maritime origin and the other of land origin. The south-westerly maritime air flowing over the Indian seas and Peninsular India has, however, to be distinguished from the south-easterly maritime air over the Gangetic plain as 'fresh monsoon' and 'deflected monsoon' respectively owing to important differences in their properties. In the early stages of formation of a cyclone, the boundaries between the 'fresh monsoon', the 'deflected monsoon', and the 'continental air' are not ordinarily sharply defined in the lower levels and the cyclonic circulation forms only at that height at which the maritime monsoon air is warmer than the continental air.

36. Focal region and time-distance curves of the North Behar earthquake of January 15, 1934.

S. C. ROY, Colaba.

Seismograms of the great North Behar earthquake and its after-shocks obtained from the Indian and the neighbouring extra-Indian seismic stations have been analyzed with a view to determine the epicentral region and the focal depth of the earthquake. Time-distance curves have also been drawn for different seismic phases of the shock.

37. Nocturnal cooling of the atmosphere by radiation.

K. R. RAMANATHAN and L. A. RAMDAS, Poona.

The cooling of the atmospheric layers near the ground due to nocturnal radiation is generally considered to start near the ground and progress upward by eddy diffusion. The interesting discovery made by Dr. L. A. Ramdas and Mr. Atmanathan that the coolest air during radiation nights does not lie immediately in contact with the ground but lies at a height of 6" to 1 ft., shows that the above explanation is inadequate. The physical processes operative in changing the temperature of an atmospheric layer near the ground are (assuming dust-free air and cloudless skies):

- (1) Eddy diffusion;
and (2) exchange of radiation with the ground and with the atmospheric layers below and above.

If the coefficient of absorption of radiation is large, only the neighbouring layers of the atmosphere are effective in exchanging radiation while if the absorption is small, the thickness is correspondingly more. The most important constituent of the atmosphere which absorbs long-wave radiation is water vapour and it possesses for different wave-lengths absorption coefficients of widely differing values. It is shown that in dealing with the cooling of an atmospheric layer, the region of smaller absorption coefficients,—e.g. between 11 and 14—plays an important part and has also to be taken into account. The exchange of radiation with the distant upper atmospheric layers—which are much cooler than the ground—can cause a layer of air at some small height above the ground to cool more than either the ground or the air layers immediately above. It has to be remembered that during night the surface of the ground loses heat by radiation but also gains heat from inside by conduction.

38. The physical significance of the constants in Angstrom's formula for sky radiation.

P. K. RAMAN, Poona.

Among the various formulæ that have been proposed for the energy of heat radiation received during night in unit time by unit area of a horizontal surface exposed to the whole sky in clear weather, one of the most successful is that proposed by A. Angstrom. Angstrom's expression has the form:

$$S/\sigma T^4 = A - B \exp(-\gamma e)$$

where S is the sky radiation, σT^4 is the black body radiation at temperature T the temperature of the atmosphere near the ground, e is the pressure of the aqueous vapour near the ground and A , B and γ are constants. Starting from the expression for the radiation from an isothermal atmosphere at temperature T and with water constant w , it is shown that the 'constants' of Angstrom's formula are derivable from the absorptive properties of water vapour. The expression for radiation takes approximately the above simple form if we divide the absorption spectrum of water vapour roughly into the following three regions, (1) region in which absorption is very high, (2) region in which absorption is very small and negligible, and (3) region in which the absorption has a finite small value.

39. Rapidity of response of various hygroscopic substances to changes of humidity.

D. S. LUKTUK, Poona.

For finding the humidity at different levels in the atmosphere, some form of hair hygrometer is invariably employed for the registration of humidity. The interpretation of the results obtained from instruments

carried in balloons and aeroplanes depends to a large extent on the rapidity of response of the hygroscopic material to changes of humidity under different conditions of temperature and pressure. A simple apparatus designed for measuring the changes of length of different fibres and strips on subjecting them to variations of relative humidity is described and some results obtained with vegetable fibres, hair, paper, cellophane, and Cotswald wool fibre are discussed. At ordinary temperatures, paper, cellophane, and wool fibre take up more than 95% of the maximum extension in about 2 minutes, while hair requires about 5 minutes for the same extension. The response to increase of humidity is much quicker than to its decrease.

40. Condensation diagram.

G. R. PARANJPE, Y. G. NAIK, and C. V. PATEL, Bombay.

P. I. Dee (*Camb. Phil. Soc. Proc.*, Vol. 28, part I, 1932) has given a chart from which the amount of water can be read off. It is, however, found by the authors that this chart does not simplify the calculations to a great extent. A new type of condensation charts has been prepared from which the quantity of water condensed, the adiabatic lowering of temperature and the final equilibrium temperature can be easily read off by knowing only two quantities, viz., the initial temperature and the expansion ratio. These charts are useful for values of temperature between 15°C and 30°C and for expansion ratios below 1.3.

41. On a Fourier's series which diverges at an unenumerable set.

A. N. SINGH, Lucknow.

In the present paper I consider the following example which I believe to be new:—

$$\begin{aligned}
 f(x) = & \sum_{n=1}^{n=10} A_n \cos nx + \frac{1}{2^2} \sum_{\substack{n=10^2+1 \\ n=10^2+1}}^{n=10^2+10^3} A_n \cos 10^2 \cdot nx + \\
 & + \frac{1}{4^2} \sum_{\substack{n=10^4+1 \\ n=10^4+1}}^{n=10^4+10^5} A_n \cos 10^4 \cdot nx + \dots \\
 & + \frac{1}{(2p)^2} \sum_{\substack{n=10^{(2p)}+1 \\ n=10^{(2p)}+1}}^{n=10^{(2p)}+10^{(2p+1)}} A_n \cos 10^{(2p)} \cdot nx + \dots, \quad (1)
 \end{aligned}$$

where the $(p+1)$ th group is

$$\begin{aligned}
 & \frac{1}{(2p)^2} \left\{ \frac{\cos(10^{(2p)}+1)10^{(2p)}x}{\frac{1}{2} \cdot 10^{(2p+1)}x} + \frac{\cos(10^{(2p)}+2)10^{(2p)}x}{\frac{1}{2} \cdot 10^{(2p+1)}x} + \dots \right. \\
 & \left. - \frac{\cos(10^{(2p)}+\frac{1}{2}10^{(2p+1)})10^{(2p)}x}{1} - \frac{\cos(10^{(2p)}+\frac{1}{2}10^{(2p+1)}+1)10^{(2p)}x}{1} - \dots \right. \\
 & \left. - \frac{\cos(10^{(2p)}+10^{(2p+1)})10^{(2p)}x}{\frac{1}{2}10^{(2p+1)}x} \right\}.
 \end{aligned}$$

As $10^{(2p)} + 10^{(2p+1)} < 2 \cdot 10^{(2p+1)} < 10^{(2p+2)}$,
the terms are not repeated.

It can be easily shown that the series as grouped in (1) is absolutely convergent, so that $F(x)$ is a continuous function.

Let $p_1, p_2, \dots, p_n, \dots$ be a sequence of positive integers such that

$$(2p_m + 1)^3 + (2p_m)^3 + 2 < (2p_{m+1})^3.$$

It has been shown that the series (1) diverges at each point x in whose representation in the decimal scale there are zeros from the $(2p)^3$ th place up to the $\{(2p+1)+r\}$ th; where $r \geq (2p)^3 + 2$, the p 's forming a sequence as above.

The only example of a Fourier's series diverging at an unenumerable set was constructed by Steinhaus, but the points of divergence were not actually found out. Steinhaus's example has not been mentioned by Hobson in his *Theory of Functions*.

42. An extension of Heilbronn's class-number theorem.

S. CHOWLA, Waltair.

Let $h(d)$ denote the number of primitive classes of binary quadratic forms of negative discriminant d . Heilbronn (*Quart. J. of Math.* (Oxford), 5, 1934, 156-160) has recently proved that

Theorem I :—

$$\begin{array}{l} h(d) \longrightarrow \infty \\ \text{as} \quad -d \longrightarrow \infty. \end{array}$$

By a slight modification of Heilbronn's argument I show that

Theorem II :—

$$\begin{array}{l} \frac{h(d)}{2^t} \longrightarrow \infty \\ \text{as} \quad -d \longrightarrow \infty, \end{array}$$

where t is the number of different prime factors of d .

Both these results were conjectured by Gauss.

43. Continued fractions associated with Ellipsoidal Wavefunctions.

S. L. MALURKAR, Poona.

In continuation of the memoir to be published in the *Indian Journal of Physics* on the Ellipsoidal Wavefunctions an attempt was made to determine the type of continued fractions associated with the integral functions. It was found that the fractions could be put in the form given first by Furstenau.

44. A numerical theorem on the convex oval.

R. C. BOSE, Calcutta.

Consider a closed convex oval V with continuous and bounded affine curvature. If a conic has contacts of various orders with V at different points, then the sum of orders may be called the total order of contact. There exists in general a finite number of conics with total order of contact five. Such conics will be called conics of critical contact, and the contact will be called clear when the conic either completely encloses or is completely enclosed by V . There are three types of conics of clear critical contact: (a) those with a single fifth order contact, (b) those with a single third order contact and two simple contacts, (c) those with five simple contacts. Let s, d, q be the number of conics of clear critical contact

completely enclosed by or completely enclosing V , belonging to the classes (a), (b), (c) respectively. Then it is proved that the sum of $2s$ and d exceeds q by 6, while d never falls short of q . For special ovals there may exist conics of hypercritical contact, i.e. conics for which the total order of contact exceeds five. It is shown that for the purposes of the theorem stated above, every conic of clear hypercritical contact can be counted as equivalent to a number of conics of clear critical contact. The present theorem is the affine analogue of a theorem proved elsewhere by the author (*Math. Zeitschrift.*, Band 35, 1932) that for a closed convex oval V of continuous and bounded curvature, the number of completely enclosed (enclosing) circles with a single third order contact exceeds the number of completely enclosed (enclosing) circles with three simple contacts by the number 2.

45. On the integrals of a congruence of curves.

K. NAGABHUSHANAM, Waltair.

It was proved by the author that if

$$A_{ik} \frac{\partial \phi}{\partial x^i} \frac{\partial \psi}{\partial x^k} = 0,$$

at least one (if not both), of $\phi = c_1$, $\psi = c_2$, is an integral of the Pfaff's first system of equations $a_{ik} dx^k = 0$, $i = 1, 2 \dots 2n+1$, where the rank of $|a_{ik}|$ is $2n$, and A_{ik} represent the minors of a_{ik} in the determinant $|a_{ik}|$. This is here shown to be a generalization of the result that if

$$\xi^i \frac{\partial \phi}{\partial x^i} = 0,$$

then $\phi = c$ is an integral of

$$\frac{dx^1}{\xi^1} = \frac{dx^2}{\xi^2} = \dots = \frac{dx^{2n+1}}{\xi^{2n+1}}.$$

This generalization holds only for an odd number of variables.

46. Relativity in dimensions.

P. BHATTACHARYYA, Calcutta.

Concepts or entities of an absolute or universal geometry are absolute points, absolute right lines, absolute planes, etc. with their dimensions respectively equal to zero, one, two, etc. absolutely without relation to any world. They are defined in the same way and obey the same sets of axioms as the ordinary points, right lines, planes, etc. of the existing geometry. The writer has proved in this paper that the latter sets of spaces are included in the more general sets of the former.

Theorem. If W be a world whose dimensions are three absolutely, then if every absolute point of W elongates or develops into a complete absolute r -space drawn in a fixed direction, say absolutely perpendicular to the absolute hyperplane of W , and W in consequence thereof transforms into an absolutely $(r+3)$ -dimensional world W_r , the newly transformed people of W_r will not be able to detect any change whatsoever and will therefore regard themselves as well as all material objects around them three-dimensional as before.

Three-fold proofs. This phenomenon is due not to the insufficient accommodation in the retina but to the change of idea regarding dimensions which are relative. Geometry of W_r beginning from an absolute r -space as zero-dimensional is also relative; r is called Index of Space for W_r .

47. Negative or hyperfine spaces.

P. BHATTACHARYYA, Calcutta.

The analysis in the previous paper shows that the 'Space-index' of our world cannot be determined. Absolute dimensions of ourselves are therefore not three but $(r+3)$, where r is any positive integer which may or may not be equal to zero. This suggests the possibility of the existence of spaces beyond the point of our geometry. These may be called negative or hyperfine spaces. (For various interesting theorems reference may be made to 'Hyperfine Spaces' published by the author from Bethune College, 181, Cornwallis Street, Calcutta.) Two points not collinear. Two interesting right lines always equidistant from each other. Elliptic geometry and paratactic lines in Euclidean Space. An interesting phenomenon. Any material object of our world may be so held as to vanish out of sight instantaneously.

48. Some boundary problems in non-linear parabolic equations.

R. SIDDIQI, Hyderabad.

In a previous paper published in the *Math. Zeitschrift*, Vol. 35 (1932), the writer has proved that one and only one regular solution of the differential equation:—

$$\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = P(x, t, u)$$

exists which satisfies the boundary conditions.

$$u=0 \text{ for } x=0 \text{ and } x=\pi \text{ and for all } t \geq 0,$$

$$u=f(x) \text{ for } t=0 \text{ and } 0 \leq x \leq \pi.$$

In the first part of the present paper we consider the same problem for a general non-rectangular domain bounded by the x -axis and the curves Γ_1 and Γ_2 :

$$\Gamma_1: x=h_1(t); \Gamma_2: x=h_2(t).$$

It is proved that by a suitable transformation the problem can be reduced to one in a rectangular domain.

In the second part we take the mixed boundary problem for the same equation, that is to say, we consider the boundary condition:—

$$u=0 \text{ for } x=0 \text{ and } \frac{\partial u}{\partial x}=0 \text{ for } x=\pi, \text{ all } t \geq 0.$$

We show that by continuing the functions $u(x, t)$ and $f(x)$ in $\pi \leq x \leq 2\pi$ according to the method of images the solution of this mixed boundary problem can be brought to depend on that of the first problem.

49. Hydrodynamics of the flow of water from canal beds and its effects on water-logging.

N. K. BOSE and V. I. VAIDHIANATHAN, Lahore.

One of the most important applications of hydrodynamics to practical problems is to determine the percolation of water from the porous beds of canals and the effect of pumping and draining on the water-table in the sub-soil.

In 1928 one of the authors read a paper before the Indian Science Congress on some cases of flow of water in a porous medium such as sand. A number of cases were worked out and have been published in a Memoir (Vol. II, No. 1) of the Punjab Irrigation Research Institute in 1929. It was not possible then to verify these deductions by experiments

done on models. It has now been possible with the co-operation of the other author to carry out some model experiments on the flow of water in a porous medium below a canal bed with different positions of the sub-soil water-table. Photographs of the flow lines show fairly good agreement with the cases compared.

50. Transmission coefficient of the flow of water in a porous medium of known grain-size.

N. K. BOSE and V. I. VAIDHIANATHAN, Lahore.

In the past attempts have been made to calculate the transmission coefficient of the flow of water in a porous medium knowing only the grain-size of the medium. This is of great practical importance for the seepage problems in canal area, and for other agricultural operations. With this idea a number of silts have been analyzed. The analysis consists of two parts. Firstly, experiments are instituted to find the size-distribution curve of a sample. This is done by the 'Optical Lever Siltometer', devised by one of the authors. Samples of the same silt are then packed carefully in a glass tube of about 2" diameter and from 30" to 40" long (L). Velocity of the average flow of water through this pipe under different heads, h , are measured and the value of the transmission coefficient K is calculated from

$$v = K \cdot \frac{h}{L}.$$

Secondly, these data have been mathematically analyzed and the following are some of the broad conclusions:—

(a) The average diameter of the grain-size of the medium appears to have no direct bearing on the transmission coefficient, within the range examined.

(b) The two ends of the silt distribution curves, i.e. the finer and coarser components of the sample seem to have great influence in determining the magnitude of the coefficient. This is also evident from physical considerations.

(c) The average diameter D_M has been weighted for these two ends, and a new characteristic of the silt

$$\beta = \frac{D_{\text{Max}} - D_M}{D_M - D_{\text{Min}}} \times D_M$$

has been worked out for each sample and plotted against the corresponding transmission coefficient K . The relation between β and K is linear of the form

$$K = m\beta + C,$$

where $m = 2.66$, $C = -0.58$. This holds for values of K higher than 0.025 cm./sec. For lower values where very fine silt particles, such as clay, are present in the sample, the relationship is expected to be different.

The error of this formula is of the order ± 5 per cent. for average packing, the correlation being about 90 per cent.

51. Note on the stability of a spoked wheel under uniform edge thrust.

B. SEN, Krishnagore.

The wheel considered in this note consists of a circular ring of small section having thin spokes separated from each other by small angles 2α . It is supposed that the spokes extend up to the centre and have their outer ends attached to the rim, the inner ends being fixed. With this

assumption, the minimum value of the uniform normal pressure that must be applied to the rim so that the spokes may buckle, has been determined in terms of α , the elastic constants and the given cross sections of the spokes and the rim.

52. On certain features of the milky way in the Hyderabad astrographic zones.

T. P. BHASKARA SHASTRI, Hyderabad.

It has been recognized for some time, that the dark patches in the sky near the plane of the Milky Way are due to the presence of large masses of obscuring matter widely scattered in regions of low galactic latitudes. A well-known dark patch of this kind occurs near the stars ρ and ψ Ophiuchi, situated in the zones of the Hyderabad Astrographic Catalogue. The form and effect of the obscuration are best studied by means of direct counts of stars in these regions, arranged according to their brightness. For the present discussion, counts of stars have been made on the Hyderabad photographs which reach a limiting magnitude of nearly 13.0 on the photographic scale, and from the numbers counted under each group ranged according to brightness, a series of distribution plots have been prepared.

The numbers of stars of each magnitude occurring for square degree are computed for the obscured as well as the unobserved regions in the neighbourhood. It is found that the rate of increase in the number of stars with decreasing brightness differs in different parts of the sky and that in highly obscured regions, the rate of increase is exceptionally small. From the frequency curves of apparent magnitude a preliminary study has been made of the extent of obscuration by the nebulous clouds situated in the part of the sky surveyed by the Hyderabad Astrographic Catalogue.

53. On a property of the Friedmann space.

N. R. SEN, Calcutta.

The homogeneous Friedmann space is shown to possess the following minimum property. In the totality of all spaces which have spherical symmetry and where material and radiation pressure are negligible, the space which for given metric and density of matter at an instant of time has the minimum rate of expansion is the one whose rate of expansion is uniform (independent of position). The only symmetrical space which expands such that at every instant of time the space has the minimum rate of expansion consistent with its metric and density is the Friedmann space.

54. A modification of Einstein's gravitational equation.

J. GHOSH, Calcutta.

The author attempts to justify the substitution of $\frac{1}{2}$ in place of $\frac{1}{3}$ in the equation

$$G_{\mu\nu} - \frac{1}{2}g_{\mu\nu}G = -8\pi T_{\mu\nu}.$$

55. On an analogy regarding operators in Dirac's wave equation.

S. GUPTA, Calcutta.

The linearly independent operators which can be formed out of the operators in Dirac's wave equation have been grouped together in two different ways and associated with current—, electric and magnetic

moment—, and spin operators. These two sets have the peculiarity that any vector or tensor operator of the one set is expressible in terms of the corresponding operators of the other set, and the integrals p , H (for free electron) and α_4 . If the three latter are replaced by their eigenvalues, the formulæ connecting the two sets are identical with those of Lorentz transformation of the vectors and tensors from one system to another.

56. Geometrization of Physics.

S. C. BAGCHI, Calcutta.

Sophus Lie remarked that the whole of physical nature may be regarded as a system of infinitesimal transformations, the law of nature being the invariant of the transformations. The progress of physics in the 20th century bears out the truth of this profound remark. Theoretical physics is concerned with certain transformations and invariants. Geometry gives a local habitation and a name to abstract analysis. The elements of a variable phenomenon constitute a system of co-ordinates, a particular state of the phenomenon, characterized by an aggregate of its co-ordinates, is called a point; finally the aggregate of states, the whole history of the phenomenon, forms a variety. The aggregate of variable phenomena may be studied as an aggregate of geometrical varieties, concepts such as generalized spaces and generalized transformations are introduced. A relation between certain fundamental tensors and spaces furnishes a basis for the study of electromagnetic and gravitational phenomena. A geometry of aggregates with the analysis situs of topology forms the basis of quantum mechanics. Operators of definite type come into play in the generalized spaces and give a connected account of the whole domain of physics as a branch of geometry.

57. Opacity and 'degeneracy'.

D. S. KOTHARI, Delhi.

In the first part, attention is drawn to the usual error in assuming that a degenerate gas is more transparent than a non-degenerate gas at the same temperature. As a matter of fact a degenerate gas is less transparent but better thermally conducting than a non-degenerate gas at the same temperature. This result incidentally explains why metals in which the electron gas is degenerate are usually more opaque and better conducting than non-metals.

The second part deals with the calculation of opacity for the 'Relativistic-case', i.e. when the dominating frequency in the radiation corresponds to energy much greater than the rest-mass energy of the electron. It is shown that the opacity in this case arises mainly due to photon interacting with another photon resulting in the creation of the electron-position pair. Using the results of the theory given by Dirac and Oppenheimer the opacity coefficient can be calculated.

Thus we here meet with the paradoxical case of light stopping light. The application of these results is considered in the third part of the paper.

58. The neutrons and stellar structure.

D. S. Kothari, Delhi.

The discovery of neutrons raises many problems of great astrophysical interest. In this paper a detailed investigation of the possible two-phase configurations of a star of mass M and luminosity L are worked out on the assumption that the star consists of a classical-perfect gas envelope and neutron core. First the 'equations of fit' are obtained which possess some interesting new features and then their solution

is worked out by numerical methods. The physical properties, i.e. central density, central temperature, effective temperature, etc. are worked out for a model star and the astrophysical significance of these results is discussed.

59. Extension of X-table (corresponding to Fisher's Z-table) for testing the significance of two observed variances.

P. C. MAHALANOBIS and S. S. BOSE, Calcutta.

R. A. Fisher's method of comparing two observed variances depend upon the calculation of his z -statistics defined by

$$Z = \frac{1}{2} \log_e \frac{s_1^2}{s_2^2}$$

where s_1^2, s_2^2 are two variances based on n_1 and n_2 degrees of freedom.

The exact distribution of Z , which was given by Fisher, can be reduced to the following form:—

$$df = \frac{\left| \left(\frac{n_1 + n_2}{2} \right) \right|}{\left| \left(\frac{n_1}{2} \right) \right| \left| \left(\frac{n_2}{2} \right) \right|} \cdot t^{\frac{n_1}{2} - 1} (1-t)^{\frac{n_2}{2} - 1} dt$$

where

$$x = e^{2z} = \left(\frac{n_2}{n_1} \cdot \frac{t}{1-t} \right).$$

The distribution may therefore be expressed in terms of the incomplete Beta-function:

$$B_t \left(\frac{n_1}{2}, \frac{n_2}{2} \right).$$

Fisher has published a table of one per cent. and five per cent. values of z for certain values of n_1 and n_2 . In actual practice it is more convenient to use

$$x = e^{2z} = \frac{s_1^2}{s_2^2}$$

instead of z , and P. C. Mahalanobis in 1932 published a table of x based on Fisher's table of z .

In view of the importance of the test more extensive tables of ' x ' have now been directly calculated by trivariate interpolation in Karl Pearson's Tables of Beta-functions.

60. On an approximate distribution of the D^2 -statistics for small samples.

S. S. BOSE, Calcutta.

P. C. Mahalanobis gave an asymptotic expression for the D^2 -statistics (coefficient of generalized statistical distance) when the value of the mean variance S is known with considerable accuracy. In this paper the distribution of D has been obtained for the case when the variance is known only for the sample and is based on a small number of degrees of freedom.

61. On the generalized statistical distance between samples from two normal populations.

P. C. MAHALANOBIS and R. C. BOSE, Calcutta.

In a previous communication (1929, and *J.A.S.B.*, 1930) P. C. Mahalanobis had given an expression for P -dimensional statistical distance between samples from two normal populations for the case of P independent variates. In this paper the formula for P -correlated variates is discussed in detail. A preliminary survey of the possible types of alternative formulas (most of which can be represented by suitable geometrical elements in hyper-dimensional space) is also given.

62. A preliminary note on the distribution of statistics in samples from two normal populations.

R. C. BOSE, Calcutta.

The distribution theory of statistics has usually been worked out on the assumption of the samples having come from a single normal population. In certain cases (for example in the problem of the generalized P -dimensional distance) it is however necessary to assume that the two observed samples belong to two different normal populations. The distribution theory of statistics arising in such problems presents many novel features. The present note gives certain new results in this connexion.

63. A bivariate sampling experiment.

P. C. MAHALANOBIS, S. S. BOSE, and S. RAY CHAUDHURI,
Calcutta.

A bivariate normal sample of size 1,200 has been constructed having the parameters : Mean (α_x)=0, (α_y)=0; Standard Deviations $\delta_x=1$, $\delta_y=5$.

These have been utilized to obtain an experimental test of the theoretical frequency distributions of (i) the standard deviation, (ii) correlation coefficient of (r), (iii) Fisher's z -transformation of (r), (iv) regression coefficient, and (v) x -test of the ratio of variances, all based on $n=5$. Further tests are in progress.

64. Automatic taring balance.

B. D. VIRMANI, Bombay.

This paper describes a weighing machine, which besides serving just like an ordinary weighing machine, can weigh a substance in receptacles of unequal weights quite independently of the weights of receptacles, so that no previous counter-balancing is required.

65. On the equation of state for ammonia in the saturated vapour and the liquid conditions.

S. C. PATIL, Lucknow.

The Equation of State given by Ray,

$$pv = k \left[\frac{M}{v} \right] e^{\frac{a}{pv\theta}} \cdot R\theta$$

was tested for Ammonia. The Molecular Weight is found to remain constant in the vapour and liquid states. 'a' changes sign in passing from gaseous into liquid condition, and is numerically 300 times greater in the

gaseous condition. If Ray's theory of negative pressures is accepted, the change of sign is explained, and if the intrinsic pressure for liquids also could be found, the value of 'a' probably would be found numerically to remain constant as well.

66. Equivalent lens.

G. R. JAIN, Gwalior.

Equivalent lens has been defined by Edwin Edser as that single thin lens which when placed at a suitable fixed point produces an image of the same size as that produced by the combination of two lenses separated by a distance, whereas according to R. W. Stewart, the equivalent lens ought to be placed in the position of the first lens. Edser calculates the distance of the suitable fixed point as DF/f_2 behind the first lens. Since this quantity can never be zero, the equivalent lens can never occupy the position of the first lens, according to Edser's calculations. The two statements are therefore contradictory, although the mathematical relation derived by the two authors is the same.

Further, an experiment was performed to test whether the calculated focal length of the combination of two lenses separated by a known distance agrees with the experimental value. A Ceno-type optical bench was used. The light was reflected from a heliostat on to a ground glass screen via the lens system. It was possible to focus the image within a mm. The results obtained were in good agreement with a proposed formula.

67. On very large percentage error in the direct determination of c_2 in Wien's radiation formula with a pyrheliometer.

SATYENDRA RAY, Lucknow.

Hennings in *Handbuch der Physik*, B. IX, p. 552, investigates 'Genauigkeit, mit der c_2 und λ bekannt sein sollten'. During work with a post-graduate class an attempt at direct determination of c_2 was attempted, and the result as obtained with a Pyrheliometer was found to be widely divergent from the table values.

It is shown that Hennings does not take into account the factors $d\lambda_1$ and $d\lambda_2$, and which we invariably get with so-called monochromatic bands with light filters. It is shown

$$\frac{\partial c_2}{c_2} = \frac{\partial T}{T} + \frac{\frac{\partial(d\lambda_1)}{(d\lambda_1)} + \frac{\partial(d\lambda_2)}{d\lambda_2}}{\log\left(\frac{d\lambda_1}{d\lambda_2}\right) - \log\left(\frac{E_1}{E_2}\right)} + \text{etc. etc.,}$$

where the second term in the denominator can be very small while the numerator is fairly large, leading to a very big fractional error in the determination of c_2 infinitely larger than reckoned by Hennings.

68. On thermodynamical evidence of the variation of $(C_p - C_v)$ for an ideal gas with temperature.

SATYENDRA RAY, Lucknow.

Partington and Shilling, in 'The Specific Heats of Gases', p. 21, observe that constancy of C_v is a 'point not implied in our definition of an ideal gas'. In the present paper it is shown that for an ideal gas it can be thermodynamically proved that $(C_p - C_v)$ is not constant, and that it drops from an infinite value at Absolute Zero to a finite value at high temperatures.

This constitutes a serious criticism of the Kinetic Theory of Gases, which leads to the constancy of C_p . It is also a problem for the Quantum Theory.

69. Seth effect and refractivity of gases.

SATYENDRA RAY, Lucknow.

The Seth effect is a shift in the Jamin's Interferometer when an electric discharge is passed through one of the tubes found by J. B. Seth and his pupils. The discovery was not accidental.

The present writer attempts to explain the results from his theory (*Zeit. f. Phys.*, VIII, 112) that the velocity of light changes with intensity.

Assuming (a) an electric density of the gas, and (b) an exponential gradient set up in the gas during the discharge it is explained that (1) electrodeless discharge produces no Seth effect as it has no unidirectional resultant, (2) shifts are all in one direction as on account of a term $k^2\rho_0^2$, the expression for the path difference is always of the same sign, (3) shifts for the blue region of the spectrum are greater than for the red.

One fact remains, apparently, unexplained, namely that no general increase of pressure takes place. The optical verification of the results of his theory are evidence of a variation of pressure between the electrodes. This variation of pressure is not capable of affecting a micro-manometer as Seth presumes. See Ray on a Generalization of the Virial of Clausius (Polish Academy, 1926, May).

70. Formation of hills: A possible mode of formation of fold mountains.

SATYENDRA RAY, Lucknow.

In a paper before the U.P. Academy of Sciences it was reported that the earthquake disturbance of 15th January, 1934, at Lucknow was of the nature of a symmetrical wave system of which the graph was composed of stretches of plateaus (broken up into tiny ripples), ascending by gradual slopes to a plateau of maximum height, after which it descended in symmetrical steps on the other side. A tidal wave caused by the astronomical configuration of planets would explain this type of wave system.

It is suggested this type of tidal waves on the molten rocks on the earth's surface, when the rocks were solidifying, will give rise to waves of constant types which we obviously see on the hills. The author has noticed during summer vacations both hill slopes and ridges which were absolute replicas of one another, fitting kink into kink.

The probability of this being the cause of the formation of Fold Mountains is greater than the vertebral columns of the continents being formed by a succession of earthquakes gradually increasing the amplitude, through the passage of ages, of a sine curve as pictured, for example, by Professor L. Dudley Stamp, Professor of Geography, Rangoon University.

71. On fringe of light on mountain contours. (Based on a note sent to *Current Science* on 8th May, 1934.)

SATYENDRA RAY, Lucknow.

During visits to Simla, Naini Tal, and Shillong, etc. the author has noticed an unmistakable fringe of light on mountain contours.

He has seen it after sunset for more than three quarters of an hour. The colour of the fringe of greater intensity is the colour of the haze hanging on the hills at the moment.

The haze is a suspension of particles according to an exponential law. This suspension of particles on the ridge acts like a lens system that refracts the haze-light from behind it and gives rise to the appearance noticed.

72. On a solution of the differential equation of the type

$$\frac{d^2C}{dr^2} + \frac{K}{r} \cdot \frac{dC}{dr} + A \cdot C = 0.$$

SATYENDRA RAY, Lucknow.

On account of a problem in connection with Liesegang Ring deposits on a filter paper having a funnel with a fine capillary tube containing a salt solution placed at its centre (the analogue of the problem reported in *Current Science*, II, 2, pp. 91-93, 1933), a solution of the equation of the type mentioned was required.

Assuming a solution of the type

$$C = ae^{-Kr} \sin \frac{2\pi r}{\lambda}$$

the values of K and λ are found. One approximate solution gives for λ the value

$$\frac{2\pi}{A} \cdot \frac{K^2}{r^2}.$$

73. Observations on the acoustics of the Assembly Chamber, Simla.

SATYENDRA RAY, Lucknow.

The floor is rectangular, and the longer sides are lined with wide doors with heavy curtains. The front of the dais and the sides are formed into galleries in the upper storey. The front of the galleries is supported on thin pillars, and the back of the galleries has window area about $\frac{2}{3}$ of the wall area above the seats. Besides this, absorbent plaster is employed, and the floor is carpeted, and rubber is laid on the passage from the porch.

Nevertheless the acoustics is none too good.

Verifications of mathematical results already published and experimental results parallel to that obtained are reported.

74. On short circuiting of the diagonal arm in de Sauty's Bridge in special cases.

SATYENDRA RAY, Lucknow.

With a Drysdale Bridge and Cenco Oscillator (Frequency 1,000), the headphone arm was found completely shortcircuited with 0.2 m.f. capacity in one arm.

It was evidently a case of resonance with nodes at the headphone arm extremities. With a resistance of the order of 15,000 ohms introduced in the oscillator arm, the difficulty disappeared. This was a result obtained during class work with the M.Sc. Final.

75. On a Factor in the effect caused by Polishers and Abrasives in Parmeshwaran's Experiments.

SATYENDRA RAY, Lucknow.

In Science Congresses of 1928 to 1930 Professor H. Parmeshwaran has been giving his results on the effects perceived by him in the manufacture of optically plane surfaces.

Taking a cube supposed to be built of matter attracting according to inverse square law, it is shown that the pressure on the abraded surface in

the direction of the inward normal is not constant, but that at the centre of an *edge* it is about one-half of its value at the centre of the *face*, and the corners about one-fourth of the same. The polishers and abrasers will therefore grind away a surface of which contour lines would be symmetrical about the axis of the surface through the centre as well as the diagonals of the face.

It is obvious a plate formed of such gravitational matter will behave like a doubly refracting crystal.

From the figures of abrasion the law of attraction can be found out, if it depart from the inverse square law.

76. On a theory of broadening of lines and their single or multiple inversions.

SATYENDRA RAY, Lucknow.

Assuming that a plane wave of wavelength λ is incident on a plane surface with sources of the same wavelength dispersed in it, the vibrations of the sources, as modified by the absorption of energy from the incident wave, as well as in the medium due to this absorption by the particles, is investigated. The incidence of this wave on a second similar surface is then investigated.

It is shown that a broadening of the line as well as a spurious 'reversal', simple or multiple, will be produced by the amplitudes for different elements of the last plane surface differing with position in the plane, according to the author's theory of change of *velocity* of light with *amplitude*. (*Zeit. and Phys.*, VIII, 112.)

77. Relativistic Thomas-Fermi atom.

A. GANGULI, Chandernagore.

The number density of electrons in an atom as calculated by Fermi Statistics is proportional to the cube of the maximum momentum determined by equating the kinetic energy with the sum of the free energy and electric energy due to the potential of the charge cloud. Taking the relativistic Hamiltonian and using Poisson's equation we have

$$\Delta V = \frac{2^{\frac{1}{2}} \pi^2}{3} \frac{m^{\frac{3}{2}} e^{\frac{5}{2}} V^{\frac{3}{2}}}{h^3} \left(1 + \frac{eV}{2mc^2} \right)^{\frac{3}{2}}.$$

The second term is a correction to the classical Thomas-Fermi equation for $eV \ll mc^2$. But for $eV \gg mc^2$, i.e. $r \ll 10^{-11}$ cm. (Coulomb law being valid for $r \sim 0$ and atomic number ~ 102) the second term predominates. This equation has no monotonic solution and the region within which it is valid contains nuclear electrons alone and the simple Coulomb law breaks down. Hence the completely relativistic equation cannot be applied to the nucleus but may hold with modifications for an assemblage of free electrons.

Again, for moving electrons the Poisson equation is modified by introducing a time co-ordinate and the potential is to be multiplied by $\sqrt{1 - \frac{v^2}{c^2}}$. In other words for $v \sim c$, the potential is very small.

Thomas-Fermi equation may be further modified by introducing 'austach energy' E_A in the Hamiltonian. Thus

$$\Delta \left\{ mc^2 \left(1 + \frac{p_0^2}{m^2 c^2} \right)^{\frac{1}{2}} - mc^2 - E_A \right\} = \frac{32 \pi^2 e^2 p_0^3}{3 h^3},$$

where p_0 is the maximum momentum. The above equation reduces to Dirac's equation for classical cases. The relativistic equation E_A can be evaluated with difficulty and an additional Breit's retardation term is to be introduced.

78. On the formation and magnetic properties of some ferrites.

D. P. RAY-CHAUDHURI, Calcutta.

Ferrites have the general formula $mMe \cdot nFe_2O_3$ where Me is a bi-valent metal and m and n small integers. They are para- and ferromagnetic and may be prepared by (i) a wet method, (ii) a dry method, and (iii) a displacement method using $Na_2O \cdot Fe_2O_3$. Though all the three methods give the same compound the magnetizability of the compound formed may differ considerably. This is due to the microcrystals not getting time and opportunity enough for their full growth. Preparation by the dry method shows that higher the temperature and longer the time of heating the higher the susceptibility χ . Slow cooling also increases magnetizability. χ values above the Curie point are not entirely independent of field strength. This is not due to free iron or any other ferromagnetic compound of higher Curie point.

79. Measurement of magnetic susceptibility of ferromagnetic powders.

D. P. RAY-CHAUDHURI, Calcutta.

Owing to difference in grain size and in density of packing, magnetic susceptibility of powdered ferromagnetics shows different values. Ballistic and magnetometric methods of measuring χ also give different values for the same specimen, that for the former being generally lower. A magnetometric null method is devised which reduces to a minimum any error arising from the change in position of the poles in the specimen with increasing magnetic fields.

80. Magnetic viscosity in nickel ferrite.

D. P. RAY-CHAUDHURI, Calcutta.

Nickel ferrite formed by the dry method by heating up to 550°C . for four hours attains a maximum χ value of $\cdot 034$. When this powder is taken in a tube of diameter 8 mm. it shows the phenomenon of magnetic viscosity for all densities of packing. The same phenomenon was not observed when the ferrite was prepared by heating to a higher temperature, or when the diameter of the tube used was small, say 2 mm.

81. On sums of like powers.

K. SUBBA RAO, Waltair.

With the notation of author's recent papers on 'Sums of fifth powers', *Jour. Lond. Math. Soc.*, 9, (1934), pp. 172-73, and on 'Equal sums of like powers', *Math. Ztsch.*, 39, (1934), pp. 240-43, it is seen that

$$\beta(7) \leq 6, \gamma(7) \leq 9, (5)^7 = (5)^7, (5)^7 = (6)^7, (4)^7 = (7)^7,$$

and similar results in ninth powers.

82. On the nomenclature of 'polarisation'.

M. N. KRISHNAMURTHY, Calcutta.

'Polarisation' which is used for explaining various phenomena in the domain of physics and physiology appears to be an ambiguous and anomalous expression in as much as it carries different ideas at different times. Polarisation which is so characteristic of light waves, very much used in optics, cannot mean the same thing when used in electricity, where it is referred to the accumulation of ions on the electrodes and the reversal of the direction of current. Again the polarisation phenomena exhibited by muscles and nerves, though of the nature of electrical variations, in no way compute with the optical phenomena of

polarisation. Thus it is seen that the nomenclature is rather ambiguous and anomalous and would not hold its prestige in the absolute, precise, and scientific nomenclature. The idea conveyed by polarisation means one thing in the realm of optics and quite a different thing in the domain of electricity and still another in 'physiology', and as such contrary to all scientific basis and explanation. The matter needs immediate attention and a new system of nomenclature is imperative to avoid incorrect expressions which are not customary to scientific principles. A detailed discussion as to the pros and cons of the phraseology and new suggestions are embodied in the paper.

83. Application of Bessel's function to the solution of the problem of slow motion of a circular disc in viscous liquid.

MANOHAR RAY, Calcutta.

The solution of the problem of slow motion of a circular disc in viscous liquid was obtained by Oberbeck as limiting case of the motion of an ellipsoid in terms of its own gravitational potential. In this paper solutions in infinite integrals are constructed with the help of Bessel's function for slow rotational and translational motions of a circular disc in viscous liquid directly. Resistance in each case is found to be identical with the value calculated by the other method.

84. Problem of irrigation in Bengal.

A. N. MITRA, Calcutta.

Bengal is an agricultural country with copious rainfall. Vagaries of weather, however, produce famine in some tracts and excess of water in others; rivers being rain-fed dry up in the winter; irrigation and drainage facilities are poor due to physical and economic conditions. Valuable winter crops cannot be grown; rice and jute bring poor returns. Western and Central Bengal tracts are largely excluded from floods and tides by embankments. This very fact is found to be responsible for reduction in crop-output by 50% and increase in Malaria, from which five lacs of people die annually.

To remedy these unhappy conditions, the author proposes introduction of irrigation with flood-water, regulated by large sluices at the intake and outlet. Such a system of irrigation is much cheaper than the usual one of irrigation with weirs across rivers, as shown by figures.

One-third of cultivable Bengal lands lie fallow, for want of irrigation facilities. Intensive irrigation is necessary in Bengal, and can come cheaply as indicated. With irrigation it is possible to increase crop-value of Bengal by 60 crores annually, to increase general revenues, and with it to improve sanitation, fish-supply, river-channels, industries, and general welfare of the Province.

85. On relativistic polytropic spheres.

N. K. CHATTERJEE, Calcutta.

In the relativistic polytropic sphere discussed before (Zeit. f. Astrophysik, Bd. 7) the pressure density relation was taken as $p = k\rho^{1+\frac{1}{n}}$ where ρ represented the relative density of gaseous matter. In the present paper calculations are made for ρ representing the proper density for $n=3$ and $\frac{5}{3}$. It is found these spheres are much smaller and much less massive than the corresponding type of classical spheres and the relativistic spheres discussed before.

Section of Chemistry.

President :—DR. A. C. SIRCAR, M.A., Ph.D.

Presidential Address.

RECENT WORK ON THE HIGHER COAL-TAR HYDROCARBONS.

LADIES AND GENTLEMEN,

I thank you gratefully, fellow scientists, for the honour you have done me in electing me President of the Chemistry Section this year and would respectfully beseech your kind co-operation in making the proceedings of this session successful.

It has been generally the custom for the Presidents of the Chemistry Section of the Indian Science Congress to give a review of recent advances in some specialised branch of the subject, and, following the footsteps of my predecessors, I propose to attempt a short review of the recent work that has been done with the object of utilising the Higher Coal-tar Hydrocarbons.

If a non-scientist be asked to name a substance which he dislikes or hates most, I am sure he would unhesitatingly name 'Coal-tar' and I think he has justification for doing so. For by sight,—it is undoubtedly most repulsive, by smell,—beyond question, intolerably obnoxious, by touch,—far from being pleasant, by taste,—better not to mention, or in other words judging by any of our organs of senses, coal-tar has nothing to recommend in its favour. On the other hand if a student of chemistry be asked to name a substance which he esteems most, I am confident he will surely suggest the name of 'Coal-tar'.

The first synthetic organic dyestuff used in dyeing textile and other materials was prepared by Perkin from some of the constituents of coal-tar in the year 1856 and patented under the name *Mauve* (Eng. Pat., 1984/56), and since that time coal-tar, notwithstanding its very blackness and generally unpleasant characteristics, has always had a flavour of romance and magic attached to it, and the chemical investigator, who searched for its secrets, has produced from it a constant stream of most wonderful and varied products of both scientific and commercial importance.

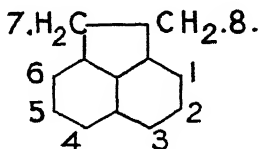
Of the various hydrocarbons occurring in the higher boiling coal-tar distillates, anthracene has already risen to importance as the starting material for the syntheses of alizarine and allied bodies. This importance has been further enhanced in later years as the result of the production from anthraquinone of the almost innumerable, fast and brilliant vat colours.

Systematic record of work done in the anthracene series is readily available. I have, therefore, tried to cover only those grounds that may appeal to those who look for unexplored fields for investigation.

The higher coal-tar hydrocarbons, to be dealt with by me, fall within the following three groups: (1) Acenaphthene group, (2) Fluorene group, and (3) Phenanthrene group.

THE ACENAPHTHENE GROUP.

Though acenaphthene ($C_{12}H_{10}$)



was first isolated by Berthelot as early as 1867, its constitutional nature was definitely settled by Bamberger and Phillip twenty years later (*Ber.*, 20, 237). In the tar distillates it is particularly found in sufficient quantities in the fraction distilling between 250°C – 300°C . It is only recently that it has received any important technical application as an intermediate in the dye-producing industry, and there is every prospect that further research in this field will yield results of importance and perhaps of considerable commercial value. Until recently acenaphthene had scarcely been isolated in a sufficiently pure state to be of technical value, but the discovery of products derived from it which are valuable dyes has led to the adoption of methods by which it can now be obtained on a commercial scale in about 95 per cent. purity. Though the known substituted derivatives of acenaphthene, in which the substituents are in the naphthalene ring, are not so prolific as are those of the simpler hydrocarbons, benzene and naphthalene, such derivatives have been prepared in a sufficiently pure state and their constitutions settled. Some of these derivatives have already proved, or are likely to prove, of value for technical purposes, when further research with them have been done. [Mention may be made, among others, of the following:—3-chloro-acenaphthene (Crompton and Walker, *J. Chem. Soc.*, 1912, 959; Sachs and Moseback, *Ber.*, 43, 2473), 2-chloro-acenaphthene (Morgan and Stanley, *J. Soc. Chem. Ind.*, 1925, 493 T), 3-bromo-acenaphthene (Graebe, *Annalen*, 327, 77; Sachs and Moseback, *loc. cit.*), 3-iodo-acenaphthene (Crompton and Walker, *loc. cit.*; Sachs and Moseback, *Ber.*, 48, 2475), 2-nitro and 4-nitro-acenaphthenes (Morgan and Stanley, *loc. cit.*), acenaphthene-3-sulphonic acid (Dziewonski and Stolyhwo, *Ber.*, 57, 1535), 3-nitro-acenaphthene-4-sulphonic acid (Morgan and

Yarsley, *J. Soc. Chem. Ind.*, 1925, 513 T), 3-hydroxy-acenaphthene, 1-nitro-acenaphthene (Morgan and Sheasby, *J. Soc. Chem. Ind.*, 1925, 408 T), 3-nitro- and 3 : 4-dinitroacenaphthene (Quincke, *Ber.*, 21, 1454), 2-nitro-3-amino- and 2-nitro-3-hydroxy-acenaphthene (Sachs and Moseback, *Ber.*, 44, 2852), 1-amino-, 3-amino-, and 2-amino-3-hydroxy-acenaphthene (Morgan and his collaborators, *J. Soc. Chem. Ind.*, 1924, 343 T ; 1925, 408 T, 493 T, 573 T, *cf.* also Sachs and Moseback, *loc. cit.* and Morgan, *loc. cit.*), 2 : 3-diamino and 3 : 4-diamino-acenaphthene (Sachs and Moseback, *loc. cit.*.) The halogenated acenaphthenes can be oxidised to the corresponding acenaphthenequinones and from the latter beautiful dyes can be obtained (*vide infra*). The nitro bodies on reduction yield the corresponding amino compounds and from these the production of azo dyes has been claimed by Holliday and Hodgkinson (Eng. Pat., 3730/83). The acenaphthene-3-sulphonic acid, on alkali fusion, replaces the sulphonic acid group by hydroxyl and Holliday and Hodgkinson in the same patent claim that the phenolic substance, *viz.* 3-hydroxy-acenaphthene, can be utilised, in the same manner as the naphthols, for the production of azo dyes. 3-Hydroxy-acenaphthene can further condense with isatin and certain of its derivatives, e.g., isatin- α -anilide, 5:7-dibromo-isatin- α -chloride and bromo- β -naphthisatin- α -chloride to form indigoid vat dyes (Bayer and Co. D.R.P. 237266, E.P. 27029 (1909), F.P. 418344, U.S.P. 998596). Derivatives of 3-hydroxy-acenaphthene, in which the ortho position to the hydroxy group is not occupied, are also claimed to undergo similar condensations yielding vat dyes. In 'Colour Index', published by the Society of Dyers and Colourists, Bradford, in which an up to date account of all synthetic dyes, which are either of scientific or technical importance, are detailed, under No. 1201 and name Alizarine Indigo B, one such dyestuff is described. It is mainly used in calico printing, it dyes in blue shades, and when printed with starch paste and chromium acetate and steamed, useful grey shades of excellent fastness to light and washing are obtained. The 2 : 3-diaminoacenaphthene, owing to the relative position of its two amino groups, readily condenses with ortho-diketones to form azines, which constitute an important class of synthetic dyes. Guha (*J. Ind. Chem. Soc.*, 1933, 10, 679) has described a few such azines. But though they dye wool from an acid bath, the shades obtained are generally yellow and are, therefore, not of so much interest from the practical dyers' point of view. The 3 : 4-diamino-acenaphthene also, owing to the relative position of its two amino groups, should condense with the anhydrides of ortho dibasic acids and in fact Sachs and Moseback have condensed it with phthalic anhydride. The phthalo-aceperinone, so obtained, forms red needles, but whether it can have any practical applicability has not been tested. Of the various possible sulphonic acids of hydroxy- and amino-acenaphthenes

only three mono sulphonic acid derivatives of 3-amino-acenaphthene are known (Morgan and Yarsley, *J. Soc. Chem. Ind.*, 1925, 513 T). 3-Amino-acenaphthene-4-sulphonic acid can couple with diazotised amines yielding azo compounds which dye wool or silk in brown shades. During the preparation of the above sulphonic acid a small quantity of 3-amino-acenaphthene-2:4-disulphonic acid is also formed, but owing to the position of the two sulphonic acid groups being adjacent to the amino group, it will not couple with diazo salts.

From an investigation on the relation between the chemical constitution and colour of azo compounds it has been found (Sircar, *J. Chem. Soc.*, 1916, 757) that in this class of compounds the shade, i.e. the depth of colour depends on the molecular complexity of the auxochrome-containing nucleus. On an examination of the constitutional formulæ of the 619 important azo dyestuffs described in the 'Colour Index' it will be found that in not less than 601 of them the auxochrome or the auxochromes are contained in naphthalene nuclei, and of these again 580 of them are sulphonated derivatives, i.e. contain one or more sulphonic acid groups in the auxochrome-containing part of the molecule. The sulphonic acid groups, though having scarcely any effect on the colour, enhance the solubility of the compounds and help in the development of even shades on textiles. In view of the relationship between the constitution of naphthalene and acenaphthene it may be confidently said that when the various possible amino- and hydroxy-acenaphthenes and their mono-, di- and tri-sulphonic acids are known, and utilised as the auxochrome containing components for the preparation of azo compounds, it is most likely that a new and very important chapter will be added to the chemistry of azo-colouring matters.

In a passing way it may be said that some of the poly-nitro naphthols and their sulphonic acids have important technical applications, e.g. *Martius Yellow* is extensively used for colouring soaps and spirit varnishes, and *Naphthol Yellow* has a wide application for colouring foodstuffs and for which purpose there is official permission in the United States of America and Australia. The poly-nitro derivatives of hydroxyacenaphthenes, when known, may find similar applications.

In the benzene and naphthalene series the innumerable products which have got any technical application as dyes, drugs, explosives, photographic chemicals, ingredients of synthetic perfumes, etc., whether directly or as intermediates, are all substituted derivatives, whereas in the case of the higher coal-tar hydrocarbons their oxidation products, the quinones, and their derivatives, are of more value.

Acenaphthenequinone was first prepared by Graebe and Gfeller (*Ber.*, 25, 652; *Annalen*, 276, 1) by oxidising acenaphthene with chromic acid, but the exact control of the oxidation condi-

tion being rather difficult, naphthalic acid and biacenaphthyliden diketone are invariably formed as by-products and the yield of the quinone is not, therefore, always satisfactory. Recently Kalle and Co. (D.R.P. 228698; F.P. 419379; also Reissert, *Ber.*, 44, 1749) has worked out a method by which acenaphthenequinone is now available in a state of purity on a commercial scale. The biacenaphthylidenediketone referred to above, and which is also obtained by the condensation of acenaphthenequinone with acenaphthene, has been claimed (D.R.P. 212858) as a vat dye. By partial oxidation of acenaphthene Kalle and Co. (D.R.P. 224979) claim the production of two other compounds which they say combine with hydroxythionaphthenes to form vat dyes. Of the possible substitution products only 3-chloro-, 3-bromo-, 3-nitro- and 3:4-dinitro-acenaphthenequinones (Mayer and Kaufmann, *Ber.*, 53, 289; Rowe and Davies, *J. Chem. Soc.*, 1920, 1344) are known.

Being an orthoquinone, acenaphthenequinone is very well adapted for the formation of azines and azonium derivatives by condensation with orthodiamines and mono-alkylated orthodiamines. Sircar and Guha (*J. Chem. Soc.*, 1924, 335) and Guha (*ibid.*, 1931, 582; *J. Ind. Chem. Soc.*, 1931, 9, 423) have described a number of such compounds. They dye wool in brownish-yellow to greenish-black shades.

According to Japp and Streatfield (*J. Chem. Soc.*, 41, 127) aromatic aldehydes react with phenanthraquinone in presence of ammonia yielding either iminazoles or oxazoles according to the chemical nature of the aldehyde utilised, but Sircar and Guha Roy (*J. Chem. Soc.*, 127, 1048) showed that by regulating the experimental conditions the same aromatic aldehyde could be made to react to yield either an iminazole or an oxazole. Extending their work to the acenaphthenequinone series Sircar and Guha Roy (*J. Ind. Chem. Soc.*, 1929, 6, 93) have prepared a number of iminazoles and oxazoles which are coloured bodies, and fairly adapted for dyeing on wool upon which they yield even shades of orange yellow to chocolate brown colour, from an acid bath. Sircar and Sen (*J. Ind. Chem. Soc.*, 1931, 8, 605) by a further study of the problem have suggested that in the condensation of aldehydes with acenaphthenequinone in presence of ammonia oxazoles are first formed and subsequent replacement of the oxygen atom of the ring by NH group results in the formation of iminazoles.

Acenaphthenequinone has already taken a prominent position as an intermediate for vat dye manufacture. In general, its use for the purpose is dependent upon the reactivity of its two CO groups in the 7:8 positions. When the quinone is condensed with indoxyl (D.R.P. 206647; E.P. 12810/08), dihalogen substituted indoxyl (D.R.P. 234178; E.P. 2105/1911) or β -naphthindoxyl (D.R.P. 235811), beautiful vat dyes, giving remarkably fast shades on cotton and wool, are obtained.

Acenaphthenequinonemono-oxime, the dioxime and naphthalene-1 : 8-dicarboxylic imide have been utilised by Kardos (D.R.P. 276357 ; E.P. 26690) for the preparation of bordeaux red vat colours. Vat colours dyeing cotton blue, blue violet, and grey violet shades are obtained (D.R.P. 276358) by nitrating the above products and treating the nitro compounds so obtained with alkaline reducing agents. In extension of the above work the use of acenaphthenequinone-diphenylhydrazone, monohydrazone, the condensation product of acenaphthenequinone and ammonia, and a number of derivatives of naphthalene -1-aldehyde -8-carboxylic acid have also been claimed (D.R.P. 286098).

The most important dyes obtained in this series are probably those obtained by the condensation of the quinone with hydroxythionaphthene and related compounds. When 3-oxy(1)-thionaphthene is condensed with acenaphthenequinone (D.R.P. 205377) or acenaphthenequinone-dichloride (dichloroacenaphthene) (D.R.P. 210813) vat dyes are obtained which colour cotton yellowish red. Bromination of the first product produces red vat dyes (D.R.P. 213504). In general it has been found that when halogens are introduced into the naphthalene portion of the acenaphthene nucleus an added affinity for cotton, together with improved light fastness and intensity, is developed. In place of oxythionaphthene, its derivatives, e.g. 6-methyl-3-oxy-(1)-thionaphthene (D.R.P. 210905), 3-oxy(1)-thionaphthene-2-carboxylic acid (D.R.P. 210813), and derivatives of 2-phenylthioglycol-1-carboxylic acid may also be utilised, e.g. 5-amino-3-oxy-(1)-thionaphthene or its 2-carboxylic acid when condensed with acenaphthenequinone yields vat dyes that are valuable in wool dyeing, producing grey black shades of extreme fastness.

Guha (*J. Ind. Chem. Soc.*, 1932, 9, 423 and 1933, 10, 679) has prepared certain vat dyes, which dye scarlet shades on cotton, by condensing 3-hydroxy- and 3-methyl-3-hydroxy-(1)-thionaphthene with chloro-, bromo-, and methoxy-acenaphthenequinones respectively. Dutt and De (*Ber.*, 1931, 64, 2602) describe some dyes obtained by the condensation of 1 : 2-diaminoquinoxaline with acenaphthenequinone. Dutt (*Ber.*, 1933, 66, 1220) has also described some more dyes obtained by the condensation of 4 : 5-diaminoacenaphthene with phenanthraquinone derivatives. These are adapted for dyeing on wool. Preparation of indigoid dyes from acenaphthenequinone and naphthathiophene-indol are subjects of subsequent communications by Dutt (*Ber.*, 1933, 66, 1230 ; *ibid.*, 1934, 67, 9 ; 1324).

Some of the vat colours derived from acenaphthenequinone, in accordance with one or other of the above-mentioned processes, have already attained considerable commercial importance and have been placed in the market by the Society of Chemical Industry, Basle, under the group name of 'Ciba Colours' (cf. Nos. 1228, 1229, and 1230 in 'Colour Index').

In acenaphthenequinone a large field is still open for investigation and there are appreciable chances that derivatives of acenaphthenequinone, now unknown, may have commercial value.

Acenaphthenone is the halfway stage in the reduction of acenaphthenequinone to acenaphthene. Like acenaphthenequinone, the reactivity of the 7 : 8-positions in acenaphthenone has resulted in its use for condensations which result in the production of vat dyes. Recently some patents have been taken for the production of vat dyes by the condensation of acenaphthenone with 2 : 3-diketodihydrothionaphthene (D.R.P. 226224) and its derivatives (D.R.P. 218992) and with derivatives of isatin or naphthisatin (D.R.P. 237819; E.P. 27773/09). Graebe and Jequier (*Annalen*, 290, 195) condensed benzaldehyde with acenaphthenone in presence of caustic soda in alcoholic solution. Kalle & Co. (E.P. 233452) have claimed the production of vat dyes by alkali fusion of the compounds obtained by the condensation of acenaphthenone with a few substituted benzaldehydes. They form red vat from which cotton is dyed blue. In extension of the above work Sircar and Raja Gopalan (*J. Ind. Chem. Soc.*, 1932, 9, 639) have condensed a large number of aromatic aldehydes with acenaphthenone.

Though a few derivatives of acenaphthenone are known (Mayer and Sieglitz, *Ber.*, 55, 1835; Friedlander, Herzog, and V. Voss, *Ber.*, 55, 1591; Beschke, *Annalen*, 369, 184, etc.), very little systematic work has been done with it. Sircar and Raja Gopalan (*J. Ind. Chem. Soc.*, 1932, 9, 103) have described some interesting pyrilium derivatives by the condensation of acenaphthenone with salicylic and β -resorcylic aldehydes. By following the procedure indicated by Robinson and Thornly (*J. Chem. Soc.*, 1926, 129, 31, 45), Sircar and Raja Gopalan (*J. Ind. Chem. Soc.*, 1932, 9, 298) obtained acenaphthindole and *N*-methyl-acenaphthindole by condensing phenylhydrazine and unsymmetrical methylphenylhydrazine respectively with acenaphthenone. By following the method of Friedlander (*Ber.*, 15, 2573; 16, 1833; 25, 1752), they have further (*J. Ind. Chem. Soc.*, 1932, 9, 299) prepared pheno-acenaphthacridine by condensing *o*-aminobenzaldehyde with acenaphthenone. The same authors (Sircar and Raja Gopalan, *J. Ind. Chem. Soc.*, 1932, 9, 643) have also studied the action of nitroso compounds on and condensation of *o*-diketones with acenaphthenone with interesting results.

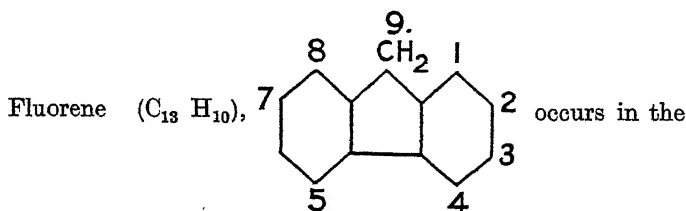
When acenaphthene is passed through a red hot tube (Dziewonski and Rapalski, *Ber.*, 45, 2491) it loses two atoms of hydrogen from its 'peri' positions and forms acenaphthylene which undergoes polymerisation rather easily (Dziewonski and Leyko, *Ber.*, 47, 1679) and forms a series of very complex hydrocarbons having beehive-like structures and to which the following names have been given,—Leucacene, Rhodacene, Chalcacene

(Dziewonski, *Ber.*, 53, 2173) and Decacyclene ($C_{38}H_{18}$). The last named compound is also obtained when sulphur reacts with acenaphthene (Dziewonski, *Ber.*, 36, 962). These hydrocarbons are extremely interesting as examples of nuclei condensations, i.e. packing up of benzenoid rings.

The polymerisation of acenaphthylene by acids has also been investigated by Dziewonski (*Ber.*, 48, 1917). The formation of diacenaphthyleneazotide (acenaphthylene-7 : 8-azine) by the action of acenaphthenequinone and ammonia under pressure, has been shown by Schonberg and Nedzati (*Ber.*, 54, 238).

The hydrocarbon aceanthrene, though not as yet isolated from coal-tar, is also interesting as it contains within its complex the essential skeleton of acenaphthene and bears the same relation to it as anthracene does to naphthalene. Its quinone, aceanthrenequinone, being an ortho diketone, condenses like acenaphthenequinone with aromatic orthodiamines to yield azines and with indoxyl or hydroxythionaphthene to build indigoid (or thioindigoid) vat dyes (D.R.P. 250157). The condensation product of its mononitro derivative with hydroxy thionaphthene, following partial reduction, it also claimed as a vat dye (D.R.P. 253762). On heating aceanthrenequinoneoxime with sulphuric acid, anthracene-1 : 9-dicarboxyimide is obtained (Kardos, *Ber.*, 46, 2086), which again is claimed as a vat dye (D.R.P. 282711). Liebermann and Kardos (*Ber.*, 47, 1253) by the action of concentrated sulphuric acid on the phenylhydrazone of hydroxyaceanthrenedione and subsequent alkali fusion of the resulting product (anthrone-hydroxypyridone) have produced a green vat dye. Kardos has taken a number of patents for the production of vat dyes by alkali fusion followed by suitable oxidation, of aceanthrenequinoneoxime (D.R.P. 275220; E.P. 12584/12; D.R.P. 284210) and by the interaction of aceanthrenequinone or its halogen derivatives with hydroxylamine or compounds yielding hydroxylamine (D.R.P. 280839). Provided aceanthrene can be had on a commercial scale, there is ample scope for the production of vat and other dyes from it in the same way as are being done in the acenaphthene series.

FLUORENE GROUP.



fraction of coal-tar distilling between 300°–340°C and pro-

cesses for its isolation in bulk, with quite reasonable ease, have been worked out. Hence, should research produce a demand for the material,—up to present no large scale commercial use has opened up,—the means of production are known. The methylene group in 9-position is remarkably active and a huge number of derivatives of fluorene and its substitution products have been obtained through this position. Mention may be made of the considerable number of compounds prepared by the condensation of 2 : 7-dichloro- and 2 : 7-dibromofluorene with aromatic aldehydes (Sieglitz and Schatzkes, *Ber.*, 54, 2072 ; Sieglitz, *Ber.*, 53, 1232). The compounds are either yellow or orange but have achieved no practical application. Holliday and Hodgkinson (E.P. 3730/1884) prepared hydroxyfluorene by alkali fusion of the monosulphonic acid and claimed the use of the hydroxy compound for the preparation of azo dyes in the same way as the naphthols are used.

More is known about the nitro derivatives of fluorene than of its other derivatives, but there is still much room for further research. The first product of nitration of fluorene is 2-nitrofluorene and when the nitration is pressed beyond the mono-nitro stage 2 : 7-dinitrofluorene results. These on reduction yield the corresponding amino compounds. The use of tetrazotised 2 : 7-diamino-fluorene and its sulphonic acid for the preparations of azo dyes has been claimed by Martius (D.R.P. 39756). The tetrazo compounds readily couple with phenols or amines and produce dyes which can be utilised for dyeing cotton direct from a soap bath. But these dyes do not appear to have become commercial articles. Another interesting derivatives of fluorene is 1 : 2-diaminofluorene and it should give rise to a number of interesting products were its investigation systematically proceeded with.

Little is known of the possible quinones derivable from fluorene. As the chain connecting the two benzene rings contains only one carbon atom, quinones of the type of acenaphthenequinone or phenanthraquinone are obviously out of question. Such quinones as are possible must, therefore, derive their quinone structure from the two benzenoid nuclei. There is field for research in this direction too. Dutt, Prasad, and De have recently (*J. Ind. Chem. Soc.*, 1932, 9, 211) described some fluorenophenanthrazines obtained by the condensation of 1 : 2-diaminofluorene with various substituted phenanthraquinones. These azines dye wool in yellow to brown shades. In another communication (*Ber.*, 1932, 65, 1793) Dutt has described a further series of compounds, obtained by the condensation of the diamine with acenaphthenequinone, isatin and some of their derivatives, which also dye wool in yellow to brownish red shades. There is still much field for work with the diamine.

When fluorene is oxidised the methylene group in 9-position is converted to 'CO' and fluorenone, which is obtained in good

yield and purity, is the sole product. Fluorenone can also be prepared from phenanthraquinone (*vide infra*) by elimination of a carbon atom and from diphenic acid by closing of a ring. Though a large number of substituted derivatives of fluorenone are described in literature, it may be said that they have been prepared more for the addition of new compounds in the series than for any technical application. Surprisingly not much has been published respecting the chlorine derivatives of fluorenone, whilst the bromine derivatives have not received any more attention and the work on the iodine substitution products appears to be still more lacking. No attempt has yet been made for the utilisation of the hydroxy- and amino-fluorenones as second components for the preparation of azo dyes. In fact, until quite recently no dyestuff had been prepared from fluorenone. Underwood and Kochmann (*J. Amer. Chem. Soc.*, 1923, 45, 3071) condensed fluorenone with phenol and resorcinol, but the resulting products do not possess quinonoid structure.

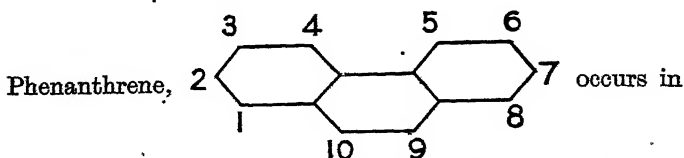
The -N : CH- group, like the azo linking -N : N- is known to enhance tinctorial properties (*cf.* Green and Sèn, *J. Chem. Soc.*, 1920, 224; Morgan and Reeves, *ibid.*, 1922, 1; Sircar and Sen Gupta, *J. Ind. Chem. Soc.*, 1924, 1, 321) and successful attempts have been made by Sircar and Bhattacharya (*J. Ind. Chem. Soc.*, 1931, 8, 637) of creating azo-methine groups in the fluorenone molecule by condensing various aromatic aldehydes with 2-aminofluorenone. These fluorenone-azo-methines, though fairly deep coloured, are found to be not satisfactory so far as their dyeing properties are concerned. They have no affinity for cotton and are decomposed into the original components when boiled with water for some time in presence of an acid. They can, however, dye wool from a one per cent. acetic acid bath between 80°-85°C, but though the bath is exhausted, the shades obtained on wool are neither very bright nor deep. The same authors (*loc. cit.*) have described a number of azo-derivatives obtained by coupling 2-diazo-fluorenone chloride with various phenols and amines. The majority of these fluorenone-azo-derivatives possess well-developed tinctorial properties and dye wool evenly from acid bath in shades ranging from orange-yellow to deep scarlet and bluish-violet. In a subsequent communication Sircar and Bhattacharya (*J. Ind. Chem. Soc.*, 1932, 9, 521) have described a number of bis-azo-compounds, obtained by coupling various amino and phenolic constituents with tetrazotised 2 : 7-diaminofluorenone. The bisazo-dyes are substantive to cotton, to which majority of them impart brown to violet shades. The bisazo-dyes obtained by coupling tetrazotised 2 : 7-di-aminofluorenone with H-acid (1-hydroxy-3-amino-naphthalene-3 : 6-disulphonic acid), Y-acid (2-amino-8-naphthol-6-sulphonic acid), and chromotropic acid (1 : 8-dihydroxy-naphthalene-3 : 6-disulphonic acid), however, dye cotton in beautiful blue shades. They also dye wool from

an acid bath but the shades on wool are lighter than their shades on cotton.

A large class of vat dyes, which are all very simple and chain derivatives, have been obtained from anthraquinone, e.g. anthraquinonylamides (D.R.P. 216772; E.P. 400653, etc.), anthraquinonylene diamides (D.R.P. 213500; 238488; 236979, etc.), dianthraquinonyldiamides (D.R.P. 224808; 270579; 210019; 212436, etc.), etc. In the expectation that similar interesting derivatives could also be obtained in the fluorenone series, Sircar and Bhattacharya (*J. Ind. Chem. Soc.*, 1931, 8, 639) condensed a good number of dibasic acid chlorides with 2-amino-fluorenone but, contrary to expectation, the resulting fluorenylamides could not be made to yield soluble vats with hydrosulphite. They, however, dye wool from an acid bath, but the shades obtained, though even, are light and rather disappointing. The same authors have also described the preparation of 2-iodo-fluorenone from the corresponding amino-derivative *via* diazo-reaction. In connection with the investigation of vat dyes Schaarsmidt and Herzenberg (*Ber.*, 53, 1807) prepared methylphenanthro-anthraquinone-fluorenone which possess phenanthrene, anthraquinone, and fluorenone skeletons in its molecule. But, though the substance can be brought into solution by the usual hydrosulphite vat process, it has no affinity for vegetable fibres.

Another hydrocarbon, *viz.* fluoranthene which is similarly related to fluorene as acenaphthylene is to naphthalene, occurs in mixtures of high boiling hydrocarbons obtained from coal-tar. When oxidised with chromic acid fluorenone yields fluorenonequinone, which, when properly investigated, is again expected to prove a valuable intermediate for the manufacture of dyes. But no work has yet been done in that direction.

PHENANTHRENE GROUP.



the fraction of neutral coal-tar oil between 300°–400°C, and can also be synthetically obtained when stilbene, dibenzyl, toluene or a mixture of diphenyl and ethylene is passed through a red hot tube. Of the various higher coal-tar hydrocarbons, though the largest amount of work has been done with phenanthrene, still a very large and probably profitable field awaits systematic research. This becomes evident when the number of possible simpler halogen derivatives is considered along with the number actually known and described. Again the number of more highly

halogenated derivatives of phenanthrene is insignificant in comparison with those theoretically possible. 'No doubt' remarks Dr. A. E. Everest 'the fact that the researches upon phenanthrene, as upon many other of the higher coal-tar hydrocarbons, have not so readily yielded commercially valuable results as those on naphthalene and anthracene has thus far tended to cause the drift of work towards the latter hydrocarbons. However a systematic working out of the various derivatives of phenanthrene, coupled with careful determination of the exact constitutions of the products prepared, may yet raise this hydrocarbon to a place of commercial prominence. Such work may lack the thrill of adventure, but may well yield much satisfaction to a patient worker.' Of the possible dinitrophenanthrenes also not much is known. Only three mono sulphonic-acids of phenanthrene, all obtained by the direct sulphonation of the hydrocarbon (Werner, *Annalen*, 321, 248) have been described. Fischer described a disulphonic acid and the formation of dyes (*Ber.*, 13, 317) by treatment of this disulphonic acid with phenols, particularly resorcinol. The product dyes silk yellow shade which is turned red by alkalis. 1-Hydroxy-phenanthrene is not known in the free state. 2- and 3-Hydroxy-phenanthrenes, obtained by the alkali fusion of the corresponding sulphonic acids (Werner and Kunz, *Ber.*, 34, 2525; Werner, *loc. cit.*) have, however, yielded fruitful products. They both couple with diazotised salts producing red azo colours, which dye silk in yellow shades (Werner, *loc. cit.*). 2-Hydroxyphenanthrene-3-carboxylic acid, prepared by heating 2-hydroxyphenanthrene with carbon dioxide under pressure and its 3 : 2-isomer are both strongly antiseptic. White mice died when either of these acids, mixed with one per cent. peptone solution was injected subcutaneously (Werner and Kunz, *loc. cit.*). Again both 10-amino-2-ethoxy-phenanthrene and its 10 : 3-isomer yield diazo compounds with nitrous acid (Henstock; *J. Chem. Soc.*, 1906, 1527). 9-Hydroxy-phenanthrene also gives azo colours by condensing with diazo compounds and, when heated with the hydrochlorides of phenyl or naphthyl hydrazines, forms the interesting 9 : 10-phenanthro-carbazole derivatives, containing both the phenanthrene and carbazole or naphthocarbazole nuclei in their molecules. A solution of the above oxyphenanthrene in concentrated sulphuric acid gives a colour reaction with oxidising agents (Schmidt and Lump, *Ber.*, 43, 794), whilst a similar solution of di-9-(10)-hydroxy phenanthrylamine is claimed as a delicate reagent for nitric acid. Our knowledge of the possible dihydroxyphenanthrenes is also, to a certain extent, limited.

As with anthracene and acenaphthene, more interesting results have been obtained from the quinone of phenanthrene (i.e. phenanthraquinone) than from the parent hydrocarbon. The great success that has achieved the investigation of anthraquinone derivatives as a source of fast colours naturally led to

great expectations in respect to the related phenanthraquinone. Further in phenanthraquinone which is an ortho quinone the chromophoric property is better developed than in anthraquinone which is a para quinone. (cf. *Ber.*, 57, 121, 128 ; *Z. angew. Chem.*, 37, 67.)

Even some of the simpler derivatives of phenanthraquinone possess pronounced tinctorial properties, e.g. 1-amino and 4-amino compounds give full shades on wool, whilst 1-amino-4-hydroxy compound produces dark green shades on wool. Of the dihydroxy compounds the 3:4-isomer, morpholquinone (Schmidt and Soll, *Ber.*, 32, 1521) dyes violet shades on alum mordant and blue on chrome, the 1:4-isomer, blackish violet on wool direct which passes to green on chroming. The 2:7-diamino-3:6-dihydroxy derivative produces greenish black shades on wool. 4:5-Dihydroxy-phenanthraquinone does not act as a mordant dye.

A considerable amount of work has been done on the nitration of phenanthraquinone. The nitrophenanthraquinones yield on reduction the corresponding aminophenanthraquinones and the latter bodies again produce the corresponding hydroxy-phenanthraquinones *via* the diazo reaction. These hydroxy derivatives like the amino compounds have got well-developed tinctorial properties.

A good amount of work in the direction of preparing dyes from phenanthraquinone has been done in India by late Dr. E. R. Watson and his pupils and grand-pupils.

In the expectation that the polyhydroxy-phenanthraquinones may have equally developed and interesting tinctorial properties as the simpler hydroxy derivatives, Mukherjee and Watson (*J. Chem. Soc.*, 1916, 617) tried to introduce additional hydroxyl groups into the simpler hydroxy-phenanthraquinones by methods utilised in the alizarin series, namely, by the action of sulphuric acid and manganese dioxide, and by the action of fuming sulphuric acid, but their experiments did not give results of value. Evidently the phenanthraquinone molecule was decomposed by the oxidising action of manganese dioxide and sulphuric acid and in the action of fuming sulphuric acid sulphonation and not hydroxylation took place. By the action of fuming sulphuric acid (SO_3 :70 per cent.) on 2-hydroxy-phenanthraquinone (for forty-eight hours at 30° - $40^\circ\text{C}.$), these authors succeeded in preparing a monosulphonic acid derivative of the quinone. The replacement of sulphonic acid group by hydroxyl group by potash fusion was apparently out of question as the phenanthraquinone molecule would not resist such a treatment. Graebe (*Annalen*, 167, 143) had already recorded that phenanthraquinone disulphonic acid on fusion with potassium hydroxide gives no substance like alizarin. Mukherjee and Watson (*loc. cit.*), however, succeeded in preparing a trihydroxyphenanthraquinone from 2:7-dihydroxyphenanthra-

quinone by acetylation, nitration, reduction, diazotisation and boiling with water, but the dyeing properties of the resulting product is not very interesting. These authors have also described a number of brominated nitrophenanthraquinones and nitrated bromophenanthraquinones.

In the anthraquinone series bromine atoms are easily replaced by anilino groups by Ullmann's method (*Ber.*, 34, 2174) and some of the anilino derivatives of anthraquinone have interesting dyeing properties (D.R.P. 113011, 121155, 142512, etc.). Led by these considerations Mukherjee and Watson (E.P. 9311/15) prepared a number of anilinophenanthraquinones, e.g. 2 : 7-dianilino-, 2-nitroanilino-, 4-nitroanilino-, etc., all of which produce dark-blue, green or black shades on wool. In view of the fact that many of the acylamino-anthraquinones (i.e. anthraquinonylamides) are important vat dyes (D.R.P. 216772, 229111, 240079, etc.), they further prepared a number of such derivatives, e.g. 2-benzoylamino-, 2-phthaylamino-, 2-oxalylamino-, 2 : 7-dibenzoyldiamino-, and 2 : 7-diphthalyldiamino-phenanthraquinone by the action of various acid chlorides on the corresponding amino compounds. They impart yellow to brownish orange shades on cotton, but are not very suitable for use as vat colours. Attempts by these authors to prepare more complex vat dyes were also not very successful (*J. Chem. Soc.*, 1916, 619). In brief, it may be said that of the various attempts that have been made to prepare vat colours in the phenanthraquinone series, on the lines that have proved so fruitful in the anthraquinone series, surprisingly none has yielded very satisfactory result and no phenanthraquinone derivative appears to have attained any commercial importance as vat dye.

Watson and Dutt (*J. Chem. Soc.*, 1921, 1211) attempted to prepare vat colours by condensation of dibromophenanthraquinone (D.R.P. 222206) with 2-aminophenanthraquinone, but the resulting phenanthraquinoneimide, like the acylamino derivatives mentioned before, is not suitable for use as vat colour. Bayer & Co. condensed 2 : 3-diamino- and 1 : 2-diamino-anthraquinone with phenanthraquinone and the resulting azines are claimed as vat dyes (D.R.P. 170562). Knoll & Co. (D.R.P. 247186 ; 242215) have described a number of sulphur colours, obtained by heating phenanthraquinone with sulphur in presence of a trace of iodine, which dye cotton yellow to brown shades from an alkaline hydrosulphite vat. Vat colours are also obtained when the nitro-phenanthraquinones and their derivatives are heated with sulphur and alkaline sulphides or with polysulphides (D.R.P. 247415). The condensation products obtained from monobromo- or dibromophenanthraquinone and mono- and diamino anthraquinone derivatives in general are claimed by Badische & Co. (D.R.P. 222206) as vat dyes.

Azo group in the phenanthraquinone series has been explored by several workers. Litthauer (*Ber.*, 26, 848) first showed that

azo dyes, which are substantive to cotton, could be prepared from diazotised 2 : 7-diaminophenanthraquinone. Watson and Dutt (*J. Chem. Soc.*, 1921, 1211), on the other hand, showed that azo dyes, obtained from the 4 : 5-diamino-phenanthraquinone, are not substantive to cotton but dye wool readily. Sircar and Roy (*J. Chem. Soc.*, 1924, 543) have described a large number of azo dyes obtained by coupling the diazotised amino-quinone derivatives with salicylic and hydroxy-naphthoic acids. They are mordant dyestuffs and give brown to violet shades on chrome mordanted wool from an acid bath. Sircar and Sen Gupta (*J. Ind. Chem. Soc.*, 1925, 321) have described some complex azo dyes containing an additional azine ring in their molecules, e.g. phenanthraphenazine-2 : 7-bis (1'-azo-2'-naphthol). They dye wool in violet shades. 3-Chloro-amino phenanthraquinone (Schmidt and Lump, *Ber.*, 43, 423) and 3-bromo-diamino-phenanthraquinone also yield azo dyes when their diazo salts are coupled with phenols.

A number of azo methine dyes possessing fairly developed tinctorial properties are known (*cf.* Green and Sen, etc. *vide supra*). In the expectation that similar dyes could possibly be obtained in the phenanthraquinone series, Sircar and Sen Gupta (*J. Ind. Chem. Soc.*, 1925, 323) condensed a number of aldehydes with 2-amino-, 4-amino- 2 : 7-diamino-, and 4-5-diamino-phenanthraquinones, but they found that the resulting phenanthraquinone-phenyl-azo-methines like the corresponding compounds obtained from 2-amino-fluorenone, are not satisfactory so far as their dyeing properties are concerned.

In view of the fact that heterocyclic rings containing two nitrogen atoms are generally chromophoric, Sircar and Sircar (*J. Chem. Soc.*, 1923, 1559) thought that this property of the five membered ring in phenanthraiminazole might be further developed by substituting suitable groups in the phenanthrene and benzene nuclei, and the iminazoles, thus obtained, might possess tinctorial properties. Some dyes of the benziminazole series were already known (Lellmaun and Hailer, *Ber.*, 26, 2760). With this object in view these authors extended the work of Japp and his collaborators (*J. Chem. Soc.*, 1880, 661 ; 1881, 225 ; 1882, 146) and found that, like the aromatic hydroxyaldehydes, aromatic nitro- and bromo-hydroxy-aldehydes also condense with phenanthraquinone and its substituted derivatives in presence of ammonia, to form phenyl-phenanthraiminazoles. They have prepared a considerable number of derivatives of 2-phenyl-phenanthraiminazole, and investigated their tinctorial properties and noticed that the introduction of auxochromic groups in the benzene ring is not accompanied by a deepening of the colour, whilst the iminazoles obtained from hydroxy and amino phenanthraquinones have, all of them, well-developed tinctorial properties. - They have further prepared a number of anilino derivatives of 2-phenylphenanthraiminazoles. That the

presence of anilino groups has the effect of deepening the colour of some of the phenanthraquinone derivatives had been previously observed by Sircar and Dutt (*J. Chem. Soc.*, 1922, 1944; *cf.* also Eng. Pat. 9311 of 1915, etc.). The colour developed on the fibre by these anilinophenanthraiminazoles is markedly influenced by the position of the anilino group. Situated in the benzene nucleus, it produces shades ranging up to violet only, but its introduction into the phenanthrene nucleus causes an appreciable deepening of the colour on the fibre. The simultaneous introduction of anilino groups into both nuclei yields better results, shades ranging even up to bluish black being obtainable. The phenanthraiminazoles are almost insoluble in water, but, when freshly precipitated from concentrated sulphuric acid solution by the addition of water, are fairly well adapted for dyeing on wool; in several cases it being found advantageous to use chrome mordanted wool.

Fries (D.R.P. 130743) has claimed the oxazine derivatives of phenanthrene, produced on heating the reduction products of nitroso-dialkyl-*m*-aminophenols with phenanthraquinone, as dyes giving clear blue shades of marked fastness to light and acid on tannined cotton. By substituting the dialkyldihydroxy-*p*-diamine mentioned above by thio-sulphonic acids of aromatic *p*-diamine and condensing them with phenanthraquinone, Fries (D.R.P. 126963) also prepared related thiazine dyes, giving greenish blue shades of good fastness to washing, light, and acids on tannin mordanted cotton. A number of compounds, obtained by the reaction of *o*-hydroxyaryl hydrazine sulphonic acids with phenanthraquinone (D.R.P. 258017), have well-developed tinctorial properties. They are mordant wool colours and give violet to deep-blue shades of excellent fastness to light and milling, on chrome mordanted wool. Watson and Dutt (*J. Chem. Soc.*, 1921, 1211) condensed 2 : 7-diaminophenanthraquinone with two molecules of phenylhydrazine-*p*-sulphonic acid, but the resulting product dyes wool in brown shades only, which again are not very fast. Yellow dyes of good fastness are obtained (D.R.P. 90212 and 90213) when phenanthraquinone is condensed with 7 : 8-diamino-1-naphthol-3-sulphonic acid or 1-2-diamino-naphthalene-disulphonic acid and the sulphonic acid groups subsequently replaced by hydroxyl by alkali fusion. But these products do not appear to have been put on the market.

Being an ortho quinone, phenanthraquinone reacts with various *o*-diamines and their derivatives to form azines and azonium derivatives. Compounds of the phenanthraphenazine type have been the subject of much research. But the dyeing properties of the simpler derivatives obtained from the unsubstituted phenanthraquinone, owing to the lightness of their colours, are not satisfactory. Watson and Dutt (*loc. cit.*) prepared a number of phenanthraphenazines with auxochromes in the

phenanthrene nucleus, in the expectation that they would be deep coloured dyes, being quinonoid in all possible tautomeric forms. But contrary to expectation, they are all yellow and dye light shades on wool. They next introduced auxochromes on both sides of the molecules, e.g. by condensing 2 : 7-diaminophenanthraquinone and 1 : 2 : 4-triaminobenzene, but whilst this gave much greater fastness, only yellow or orange brown shades resulted. They also prepared 2 : 7-diamino- and 2 : 7-dihydrophenanthraphenazines, but these dye yellow shades on wool.

Though flavinduline, obtained by the condensation of phenanthraquinone with *o*-amino-diphenylamine, is itself yellow, dyes of all shades have been obtained by condensing substituted ortho diamines, such as amido-diphenyl-*m*-phenylene diamine and 4-methylamino-2 : 5-tolylenediamine with phenanthraquinone (D.R.P. 79570). Watson and Dutt (*loc. cit.*) have introduced additional auxochromes on the phenanthrene side of the molecule, but the flavindulines, so obtained, are comparatively unstable substances and their dyeing properties are not interesting. In continuation of the above work Sircar and Dutt (*J. Chem. Soc.*, 1922, 1944) have prepared a number of phenanthra-naphthazines from the various substituted phenanthraquinones and 1 : 2-naphthylenediamine. They are very difficultly soluble products, which dye yellow to brown shades on wool. By introduction of sulphonic acid groups into some of these compounds, these authors, however, obtained soluble products which give rather heavier shades. They then extended their work to the introduction of anilino groups into the phenanthranaphthazine nucleus, and by replacing the halogen in bromo compounds, a good number of anilinophenanthranaphthazines were prepared. They dye full shades on wool in colours ranging from olive green to bluish green or bottle green. In further continuation of the work in this series Sircar and Dutt (*J. Ind. Chem. Soc.*, 1925, 201) tried the introduction of an additional chromophoric azine ring into the molecules of the phenanthraphenazine, described before, and they achieved this by condensing 2 : 3-diamino-phenazine (Ullmann and Mauthner, *Ber.*, 35, 4302) with phenanthraquinone and its derivatives. The phenanthraphenazinazines excel the corresponding mono-azines in so far as they dye deeper and fuller shades. But the deepening of the colour is in every case towards brownish shades and none of the compounds dye in blue or green colour. In connection with the preparation of the flavindulines, Dutt (*J. Chem. Soc.*, 1922, 1957) and Sircar and Roy (*ibid.*, 1924, 543) have proceeded further. The former author has prepared a considerable number of naphthaflavindulines and anilino-naphthaflavindulines. In the various anilino derivatives, discussed before, the anilino group occurs in the phenanthrene part of the molecule. Sircar and Roy (*loc. cit.*) have prepared a number of

anilino-flavindulines containing the anilino group in the benzenoid part of the molecule. They dye wool in brownish shades and none of them displays the desired property, namely that of dyeing in blue shades.

Finally, mention must be made of some of the very recent work of Dutt, in the direction of preparing vat dyes from phenanthraquinone. He has prepared a number of indigoid vat dyes by the condensation of various phenanthraquinone derivatives with hydroxy-thionaphthene and related compounds, e.g. brownish violet dyes with hydroxy-thionaphthene (*J. Ind. Chem. Soc.*, 1932, 9, 99), deep brown to deep chocolate dyes with 1 : 2-naphthoxy-thionaphthene (*Ber.*, 1933, 66, 1226), brown to deep violet dyes with 2 : 1-naphthoxythionaphthene (*Ber.*, 1934, 67, 5) and blue to greenish blue dyes with 2 : 3 naphthoxy-thionaphthene (*Ber.*, 1934, 67, 1319). The last series of compounds produce, like ordinary indigo, a coppery lustre when rubbed in a mortar.

Though a large number of phenanthraquinone derivatives, possessing tinctorial properties, have been prepared and described, very few of them have, as yet, attained any commercial importance. The only entry respecting colours derived from phenanthraquinone appearing in 'Colour Index' is No. 824, i.e. flavinduline which has been referred to before.

No account of phenanthrene derivatives can be complete without a reference to the part phenanthrene plays in the structure of the morphine group of alkaloids, which are a potent group of drugs. Bergall and Pschorr (*Z. Physiol. Chem.*, 58, 16) and Hilderbrandt (*Arch. Exp. Path. Pharm.*, 59, 140) have studied the physiological action of phenanthrene and some of its derivatives. The conclusions of these authors have been summarized by Dr. A. E. Everest as follows 'According to Berger and Pschorr, phenanthrene is quite harmless to animal life, but Hinderbrandt does not go quite so far and considers that the phenanthrene hydrides are less toxic than phenanthrene itself. They agree that when fed to rabbits, phenanthrene or dodecahydrophenanthrene is excreted as a compound of phenanthrene or phenanthrol and glycuronic acid, whereas 9 : 10-dihydrophenanthrene is not; 2-hydroxy-, 3-hydroxy-, and 9-hydroxy-phenanthrene, as well as phenanthrene 3-sulphonic acid, phenanthrene-9-carboxylic acid, and 4-methoxy-phenanthrene-9-carboxylic acid, all produce tetanic convulsions in rabbits, but with 3-acetylhydroxy-4 : 8-dimethoxyphenanthrene-9-carboxylic acid the effect is much milder; whilst phenanthraquinone-3-sulphonic acid does not produce this effect but causes formation of methaemoglobin. In no case is any narcotic action observed. Sufficient work, again, has not yet been done to show whether the presence of phenanthrene nucleus in morphine is connected with the convulsions which it

produces'. In the expectation of obtaining compounds of greater therapeutic value, a considerable amount of work has been done in the direction of preparing substituted morphine derivatives, e.g. *Peronin* is stated to be benzylmorphine and *Heroin* a salt of diacetylmorphine. Further investigation of such complex phenanthrene nuclei may reasonably be expected to result in the preparation of substances having useful therapeutic value.

In connection with phenanthrene mention may be made of another hydrocarbon, *viz.* retene, which has been proved by Bucher (*J. Amer. Chem. Soc.*, 32, 374) to be 8-methyl-2-isopropyl phenanthrene. Though its presence in coal-tar is problematical, it occurs in the various higher distilling wood-tar oils. It has recently been synthesised by Bardhan and Sen Gupta (*J. Chem. Soc.*, 1932, 2798) and also by Haworth, Letsky, and Mavin (*ibid.*, 1791) by quite different methods. Work in the direction of utilising retene for technical purpose has already begun, e.g. Arnot has taken a patent (D.R.P. 315623) for the preparation of nitroretene-sulphonic acid. Another patent had been previously taken by Knesch (D.R.P. 157981) for the preparation of 9 : 10-dihydroxyretene (also *cf.* Bamberger, *Ber.*, 18, 81). When retene is oxidised with chromic acid the chief product obtained is retenequinone (8-methyl-2-isopropyl-phenanthraquinone), which is an ortho quinone like phenanthraquinone and should, therefore, be suitable, provided it is obtainable on a commercial scale, like the latter quinone for the production of various types of dyes (*vide supra.*) In English patent (4217/1888) it is claimed that retenequinone-hydrazone-sulphonic acid is a dyestuff giving orange-red to bluish shades on either wool or silk.

It is significant to note that the phenanthrene nucleus has also been shewn to be the parent skeleton of the sterols, bile acids and even some of the hormones. The pioneering investigations of Wieland and Windeus in these lines have won for them the Nobel Prize in 1928. Since then a large amount of work has been done on the elucidation of their constitutions and distinguished workers have now concentrated their attention to their syntheses.

In conclusion another hydrocarbon, *viz.* chrysene ($C_{18}H_{12}$) also deserves mention. It is present in the coal-tar fraction that boils above anthracene and may be regarded as phenanthrene in which one additional benzenoid ring has been condensed in its 3 : 4-positions. When oxidised it forms the ortho quinone chrysenequinone. Notwithstanding the considerable amount of work that has been done upon chrysene our knowledge concerning even its simpler substitution products is very limited. In retene and chrysene there is ample scope for work at least for those who desire to prepare new compounds and study their constitutions.

Ladies and Gentlemen, we have had the steam revolution, the electrical revolution, and now the coal-tar revolution, and it may be safely said that in the higher coal-tar hydrocarbons, an immensely vast and to a certain extent virgin field still awaits future investigators. Whether the supply of the raw materials (*i.e.* higher coal-tar hydrocarbons) will continue as at present, will depend on the future progress of fuel carbonisation. So long as high temperature carbonisation is practised as at present, in gas and coke ovens, there will be sufficient supply of these hydrocarbons. If, in future, the high temperature carbonisation methods are replaced by a general use of low temperature carbonisation then only difficulties may well arise. In this connection it may be pointed out that in case a large demand for these higher coal-tar hydrocarbons arise, and at the same time the high temperature carbonisation practice is discontinued, the non-availability of these hydrocarbons from coal-tar may not stand in the way of their future utilisation. Already methods have been worked out by which these complex hydrocarbons can be synthetically built up from the more readily available simpler substances and should necessity arise, the inventive genius of the technical chemist would further perfect these methods and synthetically produce the hydrocarbons on a commercial scale. As an example of the trend in this direction, mention may be made of anthraquinone, which was, until recently, invariably obtained by the oxidation of anthracene, a higher coal-tar hydrocarbon. The quinone has risen to great importance as an intermediate for the manufacture of a large number of technically important mordant and vat dyes. The demand for anthraquinone has largely increased in recent years and, as the quantity obtainable by the oxidation of the available anthracene is not sufficient to meet the demand, methods have been devised by which it is now synthetically obtained on a commercial scale by the condensation of phthalic acid (obtained from naphthalene) and benzene. Similarly by the condensation of phthalic acid with toluene another technically important derivative of anthraquinone, *viz.* methylantraquinone is now being commercially prepared.

Ladies and Gentlemen, before I sit down, let me thank you for the courtesy and the boundless patience with which you have listened to me, specially when I was, during the greater part of my address, indulging in dissonant, harsh, and unmusical names of the higher coal-tar hydrocarbon derivatives.

Section of Chemistry.

Abstracts.

1. Magnetic susceptibility of some cobaltic salts and their constitution.

P. R. RAY, Calcutta.

Determination of the magnetic susceptibility of cobaltic sulphate, cobaltic alum, cobaltic cyanide, and cobaltic carbonate indicates a magnetic moment of two Bohr's magneton for the cobaltic ion. This cannot be accounted for on the basis of the accepted view regarding the magnetic moment of the ions of the first transitional series. An explanation has been suggested in conformity with the constitution of the salts.

2. Micro-determination of zinc in presence of the metals of the iron group by means of quinaldinic acid.

P. R. RAY and M. K. BOSE, Calcutta.

Zinc has been determined micro-chemically as zinc quinaldinate with quite good results in the presence of iron and aluminium, using alkaline tartrate solution to prevent precipitation of the latter.

3. On the structure of CO_3 and NO_3 ions.

P. B. SARKAR, H. C. GOSWAMI, and B. C. RAY, Calcutta.

The ordinary accepted octet theory of valency assumes that in carbonate and nitrate ions one of the oxygen atoms is connected by a double bond whereas the remaining two are connected each by a single bond to the C and N atom respectively. A critical study of the various data obtained from physical measurements, namely the X-ray, infra-red, and Raman-spectra conclusively prove that all the three oxygen atoms are equivalent, the carbon and the nitrogen atoms forming, in respective cases, stable sextets. Thus the structure of these ions can be represented by any of the three following schemes: (1) A flattened pyramid with an equilateral triangular base; the carbon or nitrogen atoms are at the top and the oxygen atoms at the three apices of the base; (2) A plane-equilateral triangle with carbon or nitrogen at the centre and the oxygen atoms at the apices of the triangle; and (3) A regular octahedral model. The last model of representation claims molecular dissymmetry and attempts were made to resolve the ion with optically active (CoEn_3) base with negative results. Meanwhile Duval in a preliminary note (*Bull. Soc. Chem.*, T 51, p. 342, 1932) claimed to have resolved the carbonate ion. A careful study of his method and data will reveal that the claim is unjustifiable. We have proved that such resolution cannot be effected.

Of the other two possible symmetrical structures the balance of evidence is, however, in favour of the pyramidal configuration.

4. Triple nitrites of the rare earths: Micro-test for Cæsium.

P. B. SARKAR and H. C. GOSWAMI, Calcutta.

Ball and Abram (*J.C.S.*, 1913, 103, 2110) prepared a number of complex bismuthinitrites of the type $\text{X}_3\text{Bi}(\text{NO}_2)_6$ and $\text{X}_2\text{Y Bi}(\text{NO}_2)_6$ where X stands for NH_4 , K, Rb, Cs, Tl, and Y stands for Li, Na, or Ag.

The classical work of Prof. Urbain regarding the use of bismuth salt in the separation and isolation of rare earths based on the isomorphic relationship is well known. This led the authors to study whether cerium forms triple nitrites like bismuth. The literature gives no description of triple nitrites of the above types.

We have been able to isolate the triple nitrite $\text{Cs}_2\text{Na Ce}(\text{NO}_2)_6$ in golden yellow octahedral crystals by the addition of CsNO_3 to a mixture of the solutions of $\text{Ce}(\text{NO}_3)_3$ and NaNO_3 . The other rare earths, namely La, Sm, Gd, likewise form octahedral crystals of the triple nitrites.

Micro-detection of caesium as the triple nitrite:—When to a drop of a solution of NaNO_2 and $\text{Ce}(\text{NO}_3)_3$ { NaNO_2 6 gm. $\text{Ce}(\text{NO}_3)_3$ 3 gm. per 100 c.c. of water} a drop of solution containing Cs up to the order of 0.5×10^{-6} gm. is added beautiful yellow octahedral crystals are obtained.

5. The action of hydrogen sulphide on chromates. Part III—Potassium dichromate.

G. S. KOTWANI, ABDUL HAMID, and H. B. DUNNICLIFF,
Lahore.

The reduction of 5% potassium dichromate by hydrogen sulphide is attended with rise of temperature which depends on the rate of passage of the gas. The reaction mixture changes in colour from orange through brown, dirty-brown to green.

The brown intermediate solid contains chromium dioxide (CrO_2) and hydroxide, a co-ordinated chromium thiosulphate, chromium tetrathionate and free sulphur. The filtrate contains unattacked potassium chromate, potassium thiosulphate and tetrathionate but no sulphide.

On gradual addition of more hydrogen sulphide the tetrathionate decreases with the amount of chromate until both disappear simultaneously.

So long as chromate is present the test for a sulphide is not given and the dichromate accounted for as thiosulphate is less than theory by the amount of tetrathionate formed.

Thiosulphate is the precursor of the tetrathionate, formed in a side-reaction owing to the mild oxidation of part of the thiosulphate by the chromate. The tetrathionate is ultimately reduced to thiosulphate by the alkaline sulphide, which develops in the reaction mixture as soon as chromate has disappeared.

The final products are—

- (a) a precipitate containing chromium hydroxide, sulphur and a complex chromium thiosulphate in which the ratio of ionic to co-ordinated thiosulphate is 2 : 1, and
- (b) potassium thiosulphate and polysulphide in solution.

The polysulphide formed depends on the temperature of the reaction, being K_2S_3 at laboratory temperatures and the pentasulphide at temperatures approaching 90°C .

In the light of previous work on the action of hydrogen sulphide on chromates, it appears that sulphate is not formed in these reductions if the concentration of hydroxyl ions is above a certain critical value and this requires further investigation.

6. The action of hydrogen sulphide on chromates. Part IV—Ammonium bichromate.

G. S. SODHI, ABDUL HAMID, and H. B. DUNNICLIFF,
Lahore.

The precipitate contains mainly chromium hydroxide, sulphur, thiosulphate also sulphide as well as co-ordinated ammonia and am-

monium ions. Tetrathionate formed by the oxidation of the sulphate by chromate is an intermediate product but the final solution contains only ammonium thiosulphate and (poly) sulphide.

7. The action of hydrogen sulphide on chromates. Part V—Ammonium chromate.

G. S. SODHI, ABDUL HAMID, and H. B. DUNNICLIFF, Lahore.

The results are similar to those described in part IV, tetrathionate appearing as an intermediate product in this reaction also.

8. The action of hydrogen sulphide on chromates. Part VII—Insoluble chromates.

H. B. DUNNICLIFF and BRAHM PRAKASH, Lahore.

At about 10°C., the final product of the reduction of lead chromate contained co-ordinated chromium sulphate, chromium thiosulphate (probably co-ordinated), chromium hydroxide, free sulphur, lead sulphide, and a little unattacked lead chromate.

At about 50 and 70°C., the final precipitates contained the same products, the sulphate and thiosulphate completely account for the oxidising power of the chromate and the free sulphur present is attributable to the oxidation of hydrogen sulphide by oxygen dissolved in water and taken up from the surrounding air and, to a minor degree, by photochemical action. Free sulphur in the 'slow reaction' at the lower temperature appears quantitatively as sulphate in the reaction accelerated by higher temperature.

The final precipitate in the reaction with silver chromate contained silver sulphide, chromium hydroxide, co-ordinated chromium sulphate, chromium thiosulphate (probably co-ordinated), free sulphur and chromium sulphite was observed for the first time. This indicates that sulphite is probably an intermediate compound in the development of thiosulphate as suggested in previous papers. Its appearance seems to depend on conditions in which its oxidation to a sulphate or the formation from it of thiosulphate is retarded or rendered impossible by the conditions of the reaction.

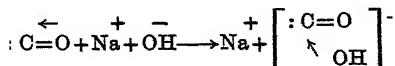
Sulphite was detected once or twice in the reduction of mercuric chromate but was not a constant product of the reaction.

The chromates of magnesium, barium, and strontium give sulphate as well as thiosulphate in the precipitate although the filtrate is very alkaline. Work is proceeding to determine the conditions which limit the formation or non-formation of sulphate in these reactions.

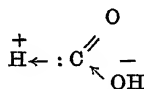
9. Constitution of formic acid and formates.

P. B. SARKAR and B. C. RAY, Calcutta.

That formic acid differs from its higher homologues in chemical properties and absorption spectra is an established fact. The acid character of its nitrile, non-existence of acid chlorides and anhydrides, the reducing character of the formate ions, led Richter to exclude it from the homologous fatty acids. These discrepancies are to be sought for in the constitution of the acid itself. Thus in the case of the formic acid the ionizable hydrogen atom is not that of the hydroxyl group, as in the case of its homologues, but the hydrogen atom attached to the carbon itself. The classical synthesis of formates from CO and KOH is explained thus :—



In the formate ion, therefore, the OH ion co-ordinates with the CO group and forms a negative ion in which carbon is practically bivalent and retains a lone-pair of electrons. To this lone-pair the reducing character of formate ion is due. It has been proved in this paper that it is the formate ion which is reducing and neither the undissociated formic acid nor its esters which have practically got a normal structure, namely

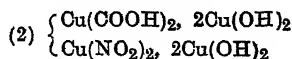
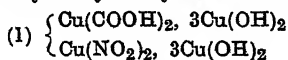


The Raman spectra of the solid $\text{Cd}(\text{CHO}_2)_2$ has shown no frequency corresponding to the C-H bond exactly what our theory demands.

Comparing the structure of the formate and nitrite ions side by side it appears that, as they are iso-steric and iso-electric, they should exhibit isomorphous relations.

In course of our investigation we have prepared the following mixed crystals :—

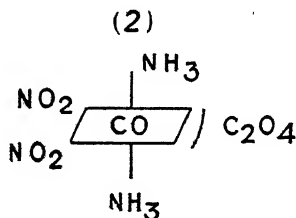
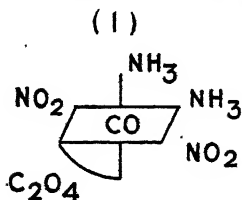
1. Barium (formate, nitrite), barium (nitrite, formate), H_2O .
2. Strontium formate with strontium nitrite.
3. Zinc formate with zinc nitrite although the latter cannot be isolated in the free state.
4. Cadmium formate with cadmium nitrite (miscibility small).
5. $\text{Mg}(\text{COOH})_2$, 2 hexamethylene tetramine, $10\text{H}_2\text{O}$.
6. $\text{Mn}(\text{COOH})_2$, 2 hexamethylene tetramine, $10\text{H}_2\text{O}$ perfectly isomorphous with the corresponding nitrites.
7. $\text{KCd}(\text{CHO}_2)_3$ isomorphous with $\text{KCd}(\text{NO}_2)_3$.
8. X-ray study of crystals of the following type is in progress :—



10. Constitution of Erdmann salt.

P. B. SARKAR and B. C. RAY, Calcutta.

Contradictory statements, regarding the constitution of oxalato-dinitro-diammine cobaltate, have been put forward by Shibata (*Journ. Coll. Scien. Tokio*, Vol. XLI, Art 2, 1917) and Riesenfeld (*Zeit. Anorg. Chem.*, 124, pp. 1-24, 1922). Thomas undertook the problem and obtained two sets of crystals by fractional crystallization of the Barium salt (*J.C.S.*, 123, 617-619, 1923). The rhombic variety is said to be resolvable and hence has a cis-cis constitution. The other monoclinic variety is arbitrarily given a cis ammonia-trans nitro configuration (formula 1). In the present paper the writers have studied the constitution of the monoclinic variety from its absorption spectra and chemical behaviour and have proved that it is a trans ammonia cis nitro compound (formula 2) thus supporting the views of Riesenfeld.



11. Intermediate compounds formed in the decomposition of chromates.

V. T. ATHAVALE, Bangalore.

A study of the decomposition of mixtures of chromates and oxides of alkaline earth shows only two stages in the decomposition corresponding to 33.3 and 40 per cent., the intermediate compounds formed being (1) $9(\text{RO}) \cdot 4(\text{CrO}_3) \cdot \text{Cr}_2\text{O}_3$ and (2) $17(\text{RO}) \cdot 6(\text{CrO}) \cdot 2(\text{Cr}_2\text{O}_3)$. This disposes off the claim for the formation of the large number of intermediate compounds found in the previous work.

Structural formulæ for these intermediate compounds based on the Werner's conception of valency have been given.

12. Hydrogen ion concentration of lead salts.

D. N. MEHTA, Bangalore.

pH values of lead oxide solutions have been determined by quinhydrone, antimony and bismuth electrodes. The results have been compared with those calculated from solubility data and it is suggested that the use of antimony electrode is not suitable in the measurements of pH values of lead salts, whereas the use of bismuth electrode is preferable to the use of antimony electrode because of the less acidic character of the former.

The pH value of solution of Sb_2O_3 has been determined, quinhydrone and antimony being employed as indicator electrodes. The value obtained with antimony electrode comes out identical with the value calculated from the solubility data.

The pH values of lead acetate, and specially prepared basic lead acetate have also been determined, bismuth, antimony, and quinhydrone electrodes being employed. Quinhydrone electrode was found the most suitable for the measurement and bismuth found to be better than the former two.

The necessity of pH control in the process of manufacture of white lead (owing to the lack of suitable indicators) has been pointed out as a very convenient means of limiting the nature of the final products.

The measurements of pH values of distilled water, conductivity water have also been carried out using the above electrodes.

13. The structure of nitrobenzylalkylamines.

BALWANT SINGH, ANAND SARUP, and H. B. DUNNICLIFF,
Lahore.

The parachors of ortho-, meta-, and para-nitrobenzyl dimethylamines, nitrobenzyl dipropylamines, and nitrobenzyl dibutylamines have been determined. The values obtained indicated that the ortho-compounds are not chelated and there is no intramolecular co-ordination in these compounds.

14. Kinetics of the reaction between α -bromopropionate and silver ions.

A. N. KAPPANNA, Nagpur.

A detailed study of the kinetics of the reaction has been made. Silver bromide formed during the course of the reaction exerts a catalytic effect. The influence of the amount of the catalyst on the velocity coefficient at constant as well as varying ionic strength has been investigated.

15. Kinetics of the decomposition of trichloroacetic acid—
Part III.

A. N. KAPPANNA and H. W. PATWARDHAN, Nagpur.

The rates of decomposition of the acid under varying conditions of acidity have been determined. An explanation of the mechanism of the reaction has been attempted.

16. Electrolytic reduction of carbonic and formic acids.

V. BHEEMIAH and M. QURESHI, Hyderabad.

The main object of this investigation is (a) to determine the nature of the electrolytic reduction of carbonic and formic acids under varying conditions of electrolysis and (b) to find out the relationship of these reductions with the over-voltage at which hydrogen is evolved at the cathode. This investigation has so far yielded the following results:—

It has been found, in conformity with the conclusions of Coehn and Jahn, that a bicarbonate is fairly rapidly reduced to formic acid on an amalgamated zinc cathode. An aqueous solution of carbonic acid is also reduced to formic acid but the yield is very small.

No formaldehyde is detected even after a prolonged electrolysis extending over 24 hours.

Formic acid alone or in the presence of sulphuric acid is reduced to formaldehyde but when the solution is alkaline no formaldehyde is formed.

The yield of formaldehyde in acidic solutions is small but it increases with the current density and the hydrogen over-voltage. Beyond a particular current density it decreases instead of increasing.

The hydrogen over-voltage in formic acid solutions does not indicate any definite change with the change in the concentration of the electrolyte. It decreases with the rise of temperature. The temperature coefficient is found to be -2.8 millivolts per degree.

The surface of the cathode and consequently the hydrogen over-voltage suffer changes during the course of each electrolysis. There is a tendency for the over-voltage to indicate a small rise in the beginning, but as the electrolysis progresses a gradual fall makes itself evident.

The above results have been critically examined but full discussion is reserved until more experimental facts are available.

17. Anomalous diamagnetism of selenium.

MATA PRASAD and S. S. DHARMATTI, Bombay.

The diamagnetic susceptibilities of the samples of selenium, powdered to different degrees of fineness, have been measured with a magnetic balance of the Wilson type. The diamagnetism of the samples decreases as the fineness of the powder is increased and at a certain stage the sample becomes paramagnetic. The paramagnetic value increases on further powdering. The value for selenium sol has also been measured and is found to be 0.7001×10^{-6} cgs. which is more paramagnetic than any of the powdered samples.

To see if any oxide effect is present we removed the oxide by washing with absolute alcohol and retested the samples; paramagnetism still persists.

18. Studies in gelation, Part I.

M. U. PARMAR, S. M. MEHTA, and MATA PRASAD,
Bombay.

Methods of Fleming, Fells, and Firth and of Hurd which depend on the change of viscosity of a gel-forming mixture as well as those which

depend on the optical properties of such mixtures have been compared with a view to find out a reliable method for measuring the time of set of silic acid gel-forming mixtures. The results lead to the conclusion that it is necessary to give a definition of what is to be understood by 'time of set of a gel-forming mixture' before any method can be selected for the purpose.

Conductometric titrations of silicic acid gel-forming mixtures have also been made in presence of hydrochloric, acetic, and citric acids.

The results of experiments on the surface tension of both acidic and alkaline gel-forming mixtures show that it decreases slightly at first and then slowly increases reaching a maximum when the gel has set.

19. Studies in gelation, Part II.

M. U. PARMAR, S. M. MEHTA, and MATA PRASAD, Bombay.

Various conditions under which thorium phosphate can be obtained in the form of a gel have been studied. It is found that completely transparent, translucent or opaque gels can be obtained by adjusting conditions of their preparation and that they can be prepared only within a limited range of pH.

The time of set of these gels and the effect of electrolytes and non-electrolytes on it have been investigated. In general the electrolytes lower the time of set whereas non-electrolytes increase it.

The effect of temperature on the time of set as well as the formation of Liesegang rings have also been investigated.

Kinetics of gelation in the case of gels obtained by using alkaline phosphate solutions have been studied by an optical method. The time required for a change from a translucent to a transparent gel has also been measured.

These results appear to throw considerable light on the structure of gels.

Various other physical properties such as viscosity, vapour pressure, etc., are being investigated.

20. Solutions of sodium zincate.

S. M. MEHTA and M. B. KABADI, Bombay.

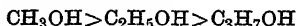
Pure crystalline zinc hydroxide, prepared according to the method of Dietrich and Johnston (*J. Amer. Chem. Soc.*, 1927, 49, 1419) was dissolved in sodium hydroxide to give solutions containing $\text{ZnO} : \text{Na}_2\text{O}$ in varying proportions. The concentrations varied from 9N to 0.5N. The electrical conductivities of these solutions have been measured and the results show that the conductivity of sodium hydroxide is diminished by the addition of zinc hydroxide between the ratios 1 : 1.76 and 1 : 3 for solutions not less dilute than 4N. This may be due to the formation of a zincate in these solutions. This seems corroborated by the fact that colourless needle-shaped crystals have been obtained from the most concentrated solutions which on analysis appear to be those of a definite zincate. It is also observed that a crystalline precipitate which is probably zinc hydroxide separates from solutions less dilute than 4.5N on standing for some time. Further work is being continued on an examination of various properties of these solutions and those of the crystals.

21. Studies on titanium dioxide sol.

S. M. MEHTA and MISS OLIVE JOSEPH, Bombay.

The changes in the viscosity of the titanium dioxide sol dialysed and diluted to different extent have been measured in presence of mono-, di- and trivalent electrolytes using Scarpa's method with suitable modifications. The viscosity at first increases, reaches a maximum, and then

begins to decrease. The time-viscosity curves are not 'S' shaped as observed by Gann. If, on the other hand, these measurements are made in the presence of mixtures of electrolytes and alcohols the viscosity rises to a maximum as in the case of electrolytes alone but the time-viscosity curves are 'S' shaped. It is found that the alcohols exert a peptising influence on the coagulation of the titanium dioxide sol. The peptising influence of the alcohols is in the order :



Changes in the pH of these sols have also been measured.

22. Electrical conductivity of solutions of sodium phosphate.

S. M. MEHTA and S. M. SHETH, Bombay.

The electrical conductivity of solutions containing sodium hydroxide and orthophosphoric acid in varying proportions expressed in terms of $\text{Na}_2\text{O} : \text{P}_2\text{O}_5$ in the ratios (i) 1.5 : 1, (ii) 1 : 1, (iii) 1 : 1.5, (iv) 1 : 2, (v) 1 : 2.5, (vi) 1 : 3 have been measured at various dilutions between 2N and 0.005N at 30°C. It is found from the equivalent conductivity-ratio curves that the electrical conductivity of these solutions decreases at first as the ratio is changed from 1.5 : 1 to 1 : 1 and then begins to increase. The minima obtained in the curves appear to correspond to NaH_2PO_4 , i.e. to the neutralisation of the first hydrogen of phosphoric acid. It is also observed that the minima are more marked in dilute solutions than in concentrated ones. The observed increase in conductivity with an increase in dilution is expected as being due to increased dissociation of the salt in solution.

The pH of these solutions are being measured by the electrometric method.

23. Reaction between solutions of sodium phosphate and mercuric chloride.

S. M. MEHTA and S. M. SHETH, Bombay.

Mellor (*Treatise on Inorganic Chemistry*, Vol. V, p. 17) states that a solution of mercuric chloride reacts with one of borax giving a red precipitate and that this reaction is sometimes styled G. Tammann's reaction for free borates. It is found that a similar precipitate can be obtained by the interaction of a solution of $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ with that of mercuric chloride: the colour and composition of this precipitate can be varied by adjusting conditions of precipitation. A search of literature has revealed that similar precipitates have been obtained by Haack (*Liebig. Ann.*, 262, 188, 1891) but that he has investigated the problem from a different standpoint. The variations in the colour and composition of the precipitates obtained by the reaction between solutions of $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ and of mercuric chloride as well as the change in the specific gravity and other properties of the precipitates have been investigated under different conditions. The results show that the physical properties of the precipitates are correlated with the pH of the alkali phosphate solutions.

24. An X-ray investigation of the crystals of Benzoin.

MATA PRASAD and JAGDISH SHANKAR, Bombay.

Benzoin was prepared by shaking together pure benzaldehyde and pure potassium cyanide in a sealed glass tube at 100°C. The crude product was purified by repeated crystallizations from rectified spirit. Well-developed crystals were obtained by the slow evaporation of the solution of the substance in alcohol.

The crystals were investigated by the Rotation Method using a Shearer gas tube and a copper anticathode. The dimensions of the unit cell were found to be

$$a=19.7\text{\AA}, \quad b=5.81\text{\AA}, \quad c=10.5\text{\AA}, \quad \text{and} \quad \beta=106^{\circ} 52'.$$

Oscillation photographs were taken at intervals of 15° about the b and the c axes and a large number of planes were identified. It was found that the (hol) planes are halved when h is odd. This halving corresponds to the space group $C5_2h$ with $\overline{1}m$ Bravais lattice. The number of molecules required by the space group is 4 and that calculated from the dimensions of the unit cell and the density of the crystal is also 4. The molecules in the cell are therefore asymmetric.

Further work on the measurement of the intensity of reflection from various planes will shortly be undertaken in order to elucidate the orientation of the molecules in the cell.

25. Pharmaceutical emulsions.

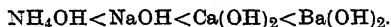
N. P. CHATTERJEE, Calcutta.

Several pharmaceutical emulsions were found, on test, to contain 30 to 40 per cent. oil, about 1 to 20 per cent. emulsifier and the pH values of the emulsions were between 4.5 to 5.5. The size of the particles was of the order of 1.5 to 80μ . The paper deals with the experiments and discussions on the preparation of emulsions with such properties. The advantages of using combinations of emulsifiers have been pointed out.

26. Titration of colloidal acids.

J. N. MUKHERJEE and S. MUKHERJEE, Calcutta.

Electrometric titrations of colloidal solutions of palmitic acid have been carried out against different alkalis. The total acidities calculated from the titration curves are found to vary with the alkali employed in the order



The results have been discussed with reference to the constitution of the double layer surrounding the particles.

27. On the measurement of the absolute rates of migration of ions by the method of moving boundaries.

J. N. MUKHERJEE, R. P. MITRA, and A. K. BHATTACHARYYA, Calcutta.

The method of moving boundaries has not hitherto been applied for a direct determination of the absolute rate of migration of an ion from an actual measurement of the potential gradient at the boundary. An attempt in this direction has been made following Mukherjee's method of measuring the cataphoretic speeds of colloidal particles. The observed potential differences between two fixed planes at right angles to the direction of the current, when a hydrochloric acid-picric acid boundary moves between them, have been found to vary regularly (i) with the distance swept by the boundary and (ii) with time. These variations have been utilized for calculating the absolute rates of migration of the chloride and the picrate ions. Better reproducibility is obtained with the more concentrated solutions where variations from mean values are within 1.5 per cent. The results appear to depend upon factors operating at the boundary in a manner not contemplated in the simple Kohlrausch theory.

28. On the nature of colloidal acid clay.

J. N. MUKHERJEE and R. P. MITTRA, Calcutta.

Acid colloidal clay has been separated from different samples of soil with the help of the Sharple's supercentrifuge. Simultaneous potentiometric and conductometric titrations of these acid clays have been carried out using different alkalis. The titration curves for a given specimen show (i) that the buffer action towards given additions of alkali depends on the nature of the alkali itself and (ii) that the time of interaction is also an important factor. Titration with acids have been carried out in order to ascertain to what extent these acids act as amphoteric electrolytes and react with hydrogen ion to form aluminium ions.

29. On the nature of colloidal acids.

J. N. MUKHERJEE, S. C. GANGULY, and B. CHATTERJEE, Calcutta.

In continuation of our previous work on colloidal acids, improvements in technique have been introduced. They include: (1) stocking the sol in an atmosphere of hydrogen free from all contaminations; (2) precautions for preventing leakage from mains, etc.; (3) efficient arrangement for shaking the system during titrations.

As a result of these improvements silicic acid sols could be preserved unchanged for months, and reproducible electrometric measurements could be obtained even at high dilutions.

The electrometric titrations of silicic acid sols against alkalis generally confirm our previous observations on the nature of colloidal acids. Buffer action is observed during titration in high pH regions.

30. Purification of activated charcoal with reference to its electrical charge and its variation with concentration of electrolytes.

S. P. RAYCHAUDHURI, S. K. NANDI, and J. K. BANERJEE, Calcutta.

Various samples of sugar charcoal have been washed and boiled with conductivity water for a long time and at different stages of washing the conductivity of the supernatant liquid and the electrical charge of the resulting sample have been measured.

All samples of charcoal which initially possessed a negative charge attained a zero charge and in two cases ultimately became positive. This confirms previous observations from this laboratory.

Variations of the electrical charge of negative and null charcoals in contact with solutions of acids, bases, and salts have been measured.

Various theories of adsorption of electrolytes by activated charcoal have been discussed in the light of the experimental results.

31. On a new type of liquid junction.

D. N. GHOSH and P. B. GANGULY, Patna.

The presence of liquid junction potentials is a source of considerable difficulty in the accurate measurement of E.M.F. of cells as owing to their instability their values cannot be accurately determined. Previous attempts have been directed towards decreasing the interfacial area of the contact and towards lowering the concentration gradient of the junction solutions. A type of liquid junction has been developed where in addition to decreasing the interfacial area diminished diffusion has been secured by decreasing the time of contact of the solutions at the junction.

Series of determinations have shown that this type of junction gives constant and reproducible values. Experiments with junctions of the free diffusion type and the continuous mixture type used by Guggenheim have also been conducted for comparison.

32. Studies on the vapour pressures of emulsions.

P. B. GANGULY, Patna.

The vapour pressures of a series of oil-in-water and water-in-oil emulsions have been measured. A type of apparatus suitable for the above measurements is described. It has been found that the vapour pressures of the emulsions generally approximate the values for the liquid forming the continuous phase. Advantage might be taken of this behaviour to definitely fix the type of an emulsion.

33. Viscosity of dilute solutions of non-electrolytes.

BALBHADRA PRASAD, Cuttack.

The study of the viscosity of dilute solutions of non-electrolytes about which a note was published in the Chemistry Section of the Science Congress last year, has been further pursued. The formula derived connecting viscosity and concentration is $\frac{\eta}{\eta_0} = 1 + \alpha c$ when η and η_0 are the viscosities of the solutions and the pure solvent respectively, α is a constant which should be independent of temperature and solute. While it is found that α is independent of temperature in the cases of cane sugar, fruit sugar, and grape sugar solutions it is not independent of the solute used. How it varies with the solute is being investigated.

34. Viscosity and molecular association.

BALBHADRA PRASAD, Cuttack.

A new method for studying molecular association has been suggested. It has been shown that if a graph be plotted with $1/T$ as x-axis and $\log \eta$ where η represents viscosity, as y-axis, then the slope of the curve will be proportional to the molecular weight of the liquid.

The relative molecular association at any two temperatures will be proportional to the slopes at the two temperatures and so relative molecular association can be easily found. It has been shown that the slope which is constant in the case of unassociated liquids is 0.7 times the critical temperatures of liquids on the absolute scale. As no liquid remains associated at about critical temperature the value of the slope determined from the critical temperature even in the case of associated liquids will correspond to the unassociated state. Hence dividing the slope of $\log \eta$ against $1/T$ at any temperature by $0.7T_c$ will give the absolute value of molecular association.

35. On the influence of a few organic solvents on the swelling of and the absorption of dye-stuffs by silk fibres.

A. NAGARAJA RAO, Bangalore.

It is a matter of common practice during dyeing to increase its effectiveness by the addition to the dye-bath of several substances either of the nature of electrolytes or non-electrolytes. Among the several factors that are responsible for this increased efficiency, the alteration in the condition of the fibre brought about by a change in the swelling is one of the most important and a detailed and a systematic investigation of this has been undertaken with special reference to silk fibres. This enables us to determine the relationship between the nature of the added substance and the direction of the change.

In this paper the longitudinal and the transverse changes undergone by individual fibres of definite dimensions have been measured under varying concentrations of pyridine, formamide, and the different alcohols enabling us thereby to determine the total percentage increase in volume on swelling. The influence of these substances on the absorption of several direct dye-stuffs by silk fibres has also been quantitatively estimated. The surface properties of the added substance appear to be entirely responsible in effecting any alteration in the extent of absorption although specific influences also are not unlikely.

36. On the solubilities of substances.

A. NAGARAJA RAO and D. V. VENKATASUBBIAH, Bangalore.

Carnelly's thermodynamic relation correlating the melting points and the heats of fusion of solid substances gives us only the natural solubilities which are mostly different from the true experimental values. The divergences have been adduced as being due to the varying shapes of the vapour pressure-concentration curves. It is felt that this relation requires a modification by the introduction of certain specific constants of the solvent of the nature of the dielectric constant and viscosity so as to yield solubility values applicable to specific solutes and solvents.

An explanation for the alternating effect observed with the solubility of some of the homologous series of substances like the di-carboxylic acids has also been attempted by a consideration of the surface groups likely to be produced in the interfacial adsorption layer.

37. On some of the physical properties of vitamine containing vegetable juices.

A. NAGARAJA RAO and C. ANANDARAMA RAO, Bangalore.

With the advent of the physico-chemical theories of biological processes the physical properties like surface tension, adsorption, and viscosity of various plant and vegetable juices assume greater importance in the elucidation of the rôle of vitamins in animal system. In this series of investigations the authors are engaged in the determination of the surface tension of fresh tomatoe and other vegetable juices and also the effect of temperature, dilution and ageing on the same.

Certain changes of the nature of an alteration in the acidity and the formation of some alcohols appear to be produced on the ageing of the juice, which are under further investigation.

38. Autocatalysis in coagulation.

S. S. JOSHI, Benares.

In view of the well-known limitations of the applicability of Smoluchowski's theory, a number of theories have been proposed during recent years for the kinetics of coagulation, which however are not free from difficulties. An examination of the available material shows that viscosity and turbidity constitute the principal source of the data for the coagulation kinetics. Evidence is now adduced to show that the *slow* coagulation is a markedly composite process, being the resultant of a series of changes, which correspond to discontinuities observed on viscosity-time curves, indicative of the progress of coagulation (Joshi and Viswanath, *J. Indian Chem. Soc.*, 1933, 10, 329-340; Joshi and Nanjappa, *ibid.*, 1934, 11, 133-143; Joshi and Iyengar, *ibid.*, 1934, 11, 555-557). The value of such a property is a function of a number of (a) processes accessory to the main one, viz. coalescence of particles, which do not progress uniformly during coagulation. Evidence is also given for the (b) existence

of stages where the micellar and related changes are such as do not affect the property selected to measure coagulation. The operation of either of, or both (a) and (b) will give evidence of autocatalysis which is but spurious.

39. A proposed general theory for the kinetics of coagulation.

S. S. JOSHI, Benares.

Based on an extension of Freundlich's equation for the adsorption isotherm, the following equation has been deduced for the rate of coagulation in terms of ϵ , the micellar charge, m the colloid concentration, C , the electrolyte concentration and a , n , which are constants.

$$\frac{dx}{dt} = ma(C - AC)^{\frac{\epsilon}{n}}$$

It is found that Smoluchowski's general equation characteristic of the region of *rapid* coagulation (*Z. Phys. Chem.*, 1917, 92, 129) can be deduced as a particular case of the equation proposed. It also yields as another special case the well-known *empirical* equation of Paine (*Koll. Chem. Beih.*, 1912, 16, 430), and predicts the conditions under which the latter breaks down as also the corresponding sense of the drift of the 'Paine's constant'. A considerable amount of evidence has been obtained in these laboratories which shows that the effect of increasing the electrolyte concentration in increasing the rate of coagulation is *discontinuous*. This purely experimental finding is found to be deducible from the equation.

40. Coagulation of oil suspensions by mercury chloride solutions.

S. S. JOSHI and S. P. SARKAR, Benares.

This has been examined over a wide range of the normality of the above coagulant. The viscosity, turbidity, and the refractive index were measured during the coagulation; these showed the normal, familiar variations, the actual magnitude of the change being however small. As observed in numerous coagulations in these laboratories, the variation of viscosity was discontinuous with time; the nett increase in viscosity even after prolonged standing was but small in a large number of cases. Changes in the last two properties were confined to but initial stages. The observations of Joshi and Kulkarni reported elsewhere are considered as special to arsenious sulphide coagulations, and not a general characteristic of mercuric chloride as a coagulant.

41. Anomalous variations of viscosity and turbidity in the coagulation of arsenious sulphide by mercuric chloride solutions.

S. S. JOSHI and S. S. KULKARNI, Benares.

In a number of recent publications from these laboratories it has been shown that marked limitations exist in the use of viscosity change as a measure of the corresponding degree of coagulation. These limitations became conspicuous particularly in the use of *non-electrolytes* as coagulants. It was seen that some of the properties of mercuric chloride are characteristic of both the electrolytes and non-electrolytes. This and the fact that no quantitative information as regards its rôle as a coagulator is available in the literature suggested undertaking the present work. Distinct though slow coagulation of colloid As_2S_3 was observed with concentrations as low as N/800. The last was raised to N/500

(when coagulation was very quick to appear) and the viscosity of the coagulating sol determined over long periods over a wide range of the coagulator and the colloid strengths. It was found that the viscosity of the system did not show any nett rise, even when the measurements were continued up to a stage, which produced appreciable flocculations. This is interesting since an appreciable increase of viscosity on coagulation is to be anticipated from the current theories of the viscosity of a colloid, as well as from the relevant data in the literature.

Measurements were also made of the opacity of the coagulating sol with the same coagulant. The results were completely analogous to those on the viscosity, which is significant. It might be mentioned that the familiar variations of both the above properties were noticed when other coagulants were used.

42. Decomposition of sulphur dioxide in electric discharge; variation of the ionization current during the reaction.

S. S. JOSHI and K. K. SARMA, Benares.

The reaction has been studied in the pressure range 4 to 15 cms. Hg in the annular space of the well-known Siemen's ozonizer due to potentials which were increased up to 16,000 volts (r.m.s.). The nature of the final products (viz. unchanged SO_2 , SO_3 , O_2 and a peculiar white deposit the main part of which is sulphur) was independent of the applied voltage, the gas pressure and presumably of the frequency of the A.C. supply. An examination of a number of pressure-time curves showed that in general the course of the reaction was markedly composite. In the first stage of the decomposition the rate of change was slow. The duration of this stage increased by increasing the gas pressure at constant applied potential. This was followed by a short lived phase in which the reaction proceeded markedly rapidly, as judged by the diminution of the gas pressure in the system. The final section was always characterized by an exceedingly slow rate of change. On measuring the value of the ionization current flowing through the reaction vessel a remarkable correspondence was found to exist between the rate of the reaction and the corresponding current. In the first phase of the reaction mentioned already the current diminished fairly rapidly; it then increased remarkably rapidly during the short interval, when a rapid diminution of pressure was produced; the current was markedly low and nearly constant during the last stage of the decomposition. The close synchronism between the current changes and those in the corresponding rate of decomposition is striking, and is in all probability related to the changing composition of the material in the ionization vessel. Evidence is adduced to show that even small quantities of sulphur trioxide possess a markedly depressant influence on the ionization of a gas subjected to an electric discharge.

43. Formation of molecular complexes in mixed solutions of potassium iodide and mercuric chloride.

S. S. JOSHI and K. K. SARMA, Benares.

A review of the literature on the subject showed that a very considerable amount of evidence exists to show that hydroxylation and especially association lead to appreciable increase in viscosity. The last quantity was measured for mixtures in which different amount of 0.1M, HgCl_2 were added to solutions of potassium iodide. The proportion of the mercury chloride mixed with a given normality of the iodide solution was increased until precipitation of mercury iodide occurred. Measurements were made with 0.1M, 0.2M, and 0.3M KI solutions, at two temperatures, viz. 30°C. and 35°C. The curves relating the viscosity and the composition of the mixture showed a number of maxima and minima.

The positions of a number of these remained sensibly unaltered in the series mentioned above at the two temperatures. The occurrence of the maxima have been explained on the formation of complex compounds of the type $(\text{HgCl}_2)_a(\text{KI})_b$ where a and b are constants.

44. Variation of viscosity during the slow coagulation of oil-in-water emulsions.

S. S. JOSHI and H. K. ACHARYA, Benares.

A review of the now considerable volume of data on the viscosity of colloids showed that but little quantitative information is available on the viscometric examination of the kinetics of the above type of emulsions. The present paper gives data for the coagulations of *Til*, Mustard, Linseed, and Paraffin oil emulsions. Various concentrated solutions of potassium bromide, potassium iodide, barium chloride, thallium chloride, and thorium nitrate were used as coagulants. It was observed that the progress of coagulation followed by viscosity measurements was markedly discontinuous, an appreciable diminution of viscosity being observed usually though not invariably at the commencement of the coagulation. Both these features disappear in rapid coagulations contrary to expectations from the current theories regarding the viscosity of a colloid and the usual experience, it was found that in a large number of coagulations, especially when low concentrations of thallium chloride and thorium nitrate are used viscosity of the coagulating system was markedly lower than its initial value.

45. Studies on the influence of electrolytes on the distribution of solutes between immiscible solvents. Part I—Partition of benzoic acid between toluene and water.

S. S. JOSHI and R. N. AMBIKE, Benares.

Results are given for the distribution coefficient of benzoic acid between the phases mentioned above in the presence of varying amounts of hydrochloric acid, lithium, sodium, potassium, rubidium, and ammonium chloride added to the aqueous phase. The constant diminishes by about 22 per cent. when the amount of the acid for example is increased up to 0.5N. Further increase up to 4N has no influence. The addition of the other chlorides (with the exception of ammonium chloride) in increasing amounts diminishes progressively the distribution constant. The first additions of ammonium chloride increase the coefficient to a maximum; subsequent additions lower its value analogous to other chlorides. Comparing the influence of the above chloride in diminishing the distribution coefficient, the order is $\text{NaCl} > \text{KCl} > \text{RbCl} > \text{LiCl} > \text{HCl}$. The thermodynamical theory of Nernst, the familiar salting out theory and that of the suppression of the ionization of benzoic acid have been shown to be inadequate to explain the observed results. The possible influence of the ionic hydration and especially of changes in the ionic activities and also that of the undissociated benzoic acid has been discussed.

46. Studies on the influence of electrolytes on the distribution of a solute between immiscible phases. Part II—The partition of iodine between toluene and water.

S. S. JOSHI and R. N. AMBIKE, Benares.

The influence of the addition of different amounts of KCl, LiCl, NaCl, HCl, HNO_3 , CH_3COOH , H_2SO_4 to the aqueous phase on the above distribution coefficient has been investigated. It has been found that

the constant diminishes by increasing the amount of any of the above substances, the effect being more pronounced in the first additions. The order of influence is $K > Na > Li > H$ which is in part different from that observed in the benzoic acid distribution. As the amount of any of the four acids was varied progressively, it was found that the distribution constant diminished to a minimum (whose value depended upon the nature of the substance added), the influence of further additions being but insensible.

A detailed investigation was also made of the above distribution in the presence of potassium iodide in the aqueous phase, which leads to the formation of KI_3 in water. The values of the equilibrium constant ($KI \times I_2 / KI_3$) was studied in the presence of the foreign electrolytes mentioned above. The constant increases fairly rapidly as the concentration of $LiCl$, KCl , and $NaCl$ added is increased in the range 0 to 3N. Using acetic and nitric acids the constant increases up to a maximum at about 0.5N, and remains constant despite large increases in the amounts of the acids added.

47. Nitrogen loss from soil in sunlight.

N. R. DHAR, S. P. TANDON, S. K. MUKERJI, and P. K. KAR,
Allahabad.

In absence of oxygen and in presence of an easily oxidisable organic substance, many micro-organisms are capable of decomposing nitrates with the evolution of gaseous nitrous oxide or ammonia. This type of denitrification is well known. There is another variety of nitrogen loss, which takes place in presence of oxygen but has not yet been satisfactorily explained. In this paper it will be shown that this loss of nitrogen from the soil is due to an oxidation process followed by a photochemical and catalytic decomposition.

From the researches of J. G. Lipman and A. W. Blair carried on at New Jersey and California, it appears that nitrogen in the gaseous state is lost from soils when the conditions are favourable for oxidation. The loss amounted to 100 lbs. per acre per year in the first nine inches of the soil. In these experiments the conditions existing in the soil in the past were disturbed by making the soil suitable for more oxidation. Similar nitrogen losses have been observed at Rothamsted, Minnesota, Kansas, Indian Head (Saskatchewan), Allahabad, Nagpur, Coimbatore and other places. Nearly 70% of the added nitrogen is said to have been lost when wheat plots in Rothamsted have received 14 tons of farmyard manure containing 200 lbs. nitrogen. These losses are more pronounced in soils, which have been highly aerated.

That oxidation of ammonium salts is an important factor in this type of denitrification is also evident from the observations of Niklewaki, who reported that when the manure was free from nitrifying bacteria, only 3% nitrogen was lost as ammonia but when supplied with nitrifying bacteria, the manure lost more than 20% of its nitrogen. Moreover, Russell and Richards have observed a greater loss of nitrogen when a manure was composted under aerobic than under anaerobic conditions. Vishwanath has observed that the greater the nitrate formation with different manures, the greater the nitrogen loss. It has been observed that the loss of nitrogen in presence of light is always greater and the oxidation is also greater than in the dark. Experiments carried on in different countries show that the total amount of nitrate lost from soils containing crop is greater than that in neighbouring fallow soils even when correction is applied for the amount of nitrate taken up by the crop.

Explanation on the foregoing observations on nitrogen loss are given in the paper.

48. Influence of temperature on fixation of nitrogen.

A. K. MALLIK and N. R. DHAR, Allahabad.

It is generally believed that nitrogen fixation takes place to a remarkable extent in tropical soils by free living bacteria. It seems that no systematic work has been done on this subject in this country. The writers have determined the nitrogen fixed at different temperatures by a pure culture of *Azotobacter* using the following medium:—

Distilled-water	1,000 c.c.
Mannite	15 gms.
K_2HPO_4	0.2 "
$MgSO_4 \cdot 7H_2O$	0.2 "
$CaCl_2$	0.02 "
$FeCl_3$ one drop of 10 per cent. solution.			

It is well known that 90% of the nitrogen fixed is in the form of ammonia and hence we have determined the amounts of ammonia by Nessler's solution colorimetrically.

The results show that the amount of ammonia formed is highest at 35°; at 50° the amount of nitrogen fixed is exceedingly small. It seems therefore that in summer months in tropical countries when the soil temperature in many places exceeds 50°, very little nitrogen fixation by *Azotobacter* is possible.

49. Chemical reactivity and light absorption.

N. R. DHAR and P. N. BHARGAVA, Allahabad.

The writers have measured the light absorption of reducing agents like hydrogen, methyl alcohol, and ethyl alcohol vapour, and oxidizing agents like bromine and chlorine separately all in the gaseous state and in mixtures by photographing their absorption spectra with a Hilger Quartz Spectrograph E, employing copper and iron arc as the light source. The time of exposure was two minutes. The absorption chamber consisted of a tube 80 cms. long and 2.5 cms. in diameter. The pressures of bromine or chlorine and the reducing agents were 20 and 40 cms. Hg respectively.

From the results it is observed that the light absorption by a mixture of the reacting substances is greater than the absorptions by the ingredients considered separately. It is interesting to note that there is no increased light absorption when the gases or vapours are passed through concentrated sulphuric acid and phosphorus pentoxide. In other words, desiccation considerably decreases the chemical reactivity and prevents the combination of hydrogen and chlorine or hydrogen and bromine in the visible region. Hydrogen sensitizes the dissociation of chlorine and bromine molecules and makes them reactive in radiations of longer wavelengths only in the presence of moisture. These observations are supporting the important work of Baker who showed that intensive drying greatly reduces the reaction velocity of substances.

From numerous experiments carried on with solutions and the results obtained in this paper, it seems clear that if there is the possibility of the occurrence of a chemical change by mixing two or more substances increased light absorption is likely to be observed in those cases. We are of opinion that the increased light absorption by a mixture in comparison with those of ingredients is likely to be a measure of the reactivity of a given mixture of two or more substances.

50. Temperature and diamagnetism.

S. S. BHATNAGAR, M. B. NEVGI, and M. L. KHANNA, Lahore.

While trying the temperature effect on diamagnetism of some organic iodides the authors find that the diamagnetism of the iodides decreases

to some extent. This is quite contrary to the fact which was previously observed in the case of aromatic liquids. The results obtained so far are as follows :—

TABLE I.
Ethyl iodide.

Temperature.	$-\chi \times 10^6$.	% change.	Temperature coefficient.
15°C.	0.4488	2.94	0.00074
55°C.	0.4356		

TABLE II.
n-propyl iodide.

30°C.	0.4958	2.5	0.00063
70°C.	0.4834		

TABLE III.
Phenyl iodide.

30°C.	0.470	1.7	0.000425
70°C.	0.462		

TABLE IV.
o-iodo-toluene.

30°C.	0.5145	1.82	0.000457
70°C.	0.5051		

TABLE V.
m-iodo-toluene.

30°C.	0.5152	1.7	0.000422
70°C.	0.5065		

It appears from the above results that iodine in the organic iodides might perhaps be responsible for the decrease in the diamagnetism of the organic iodides. Honda (*Ann. der Physik.*, 32, 1027, 1910) has shown that iodine increases in diamagnetism in solid state but decreases in the liquid state. The slight decrease in the diamagnetism of the iodides can be explained by the change in the diamagnetism of iodine at different temperatures. The above results are in the same direction. These results will be further extended and checked on the modified form of Decker's apparatus.

51. On the accurate measurement of diamagnetic susceptibilities.

S. S. BHATNAGAR, N. G. MITRA, and G. D. TULI, Lahore.

Pascal's classical data on the deduced values of χ for atoms in combination is at its best a first approximation. An attempt has been made to repeat his work with the purest materials now available by taking measurements on the more sensitive Bhatnagar-Mathur Magnetic Interference Balance. The results obtained for hydrogen ($\chi_H = -2.68 \times 10^{-6}$) and for chlorine ($\chi_{Cl} = -19.85 \times 10^{-6}$) compare more favourably with the theoretical values derived on the wave mechanical concepts than the experimental values of Pascal.

52. Action of solvents in heterogeneous reactions. Part I.—Effect on the velocity of reaction between carbon disulphide and alkali.

D. D. KARVÉ and K. K. DOLE, Poona.

Solutions of carbon disulphide in petroleum ether and in xylene were shaken with varying quantities and concentrations of sodium hydroxide and the sulphur in the aqueous layer was estimated after one hour. It was found that the extent of reaction is greater with xylene than in petroleum ether, although in both solvents it is seen to increase proportionately with concentration.

53. Action of solvents in heterogeneous reactions: Part I. Effect on the velocity of reaction between benzoyl chloride and water.

D. D. KARVÉ and K. K. DOLE, Poona.

The velocity of the reaction between benzoyl chloride and water was determined when carbon disulphide, chloroform, carbon tetrachloride, chlorobenzene, bromobenzene, and xylene were used as solvents for the former. The extent of reaction in a given time was greatest with CCl_4 , and went on diminishing in the order: Carbon tetrachloride, xylene, carbon disulphide, chlorobenzene, bromobenzene, and chloroform. Besides the physical properties like viscosity and density, various others like surface tension, dielectric constant, etc. seem to determine this effect on the speed of a heterogeneous reaction.

54. On some critical aspects of adsorption.

A. GANGULI, Chandernagore.

Recent quantum-mechanical dispersion theory shows that there is no appreciable difference between the old capillary condensation, surface orientation, potential, and electrical theories. Adsorption forces originating from electrical polarisation are identified with van der Waal forces operative in condensation and regarded as residual valence forces. Activated adsorption however involves a mechanism of activation as in chemical kinetics. But some explain this as due to slow diffusion or of removal of impurities adhering to the surface.

In order to understand mechanism of adsorption further experiments on the structure, extent, purity and thickness of surface layer are required. Roughness of surface and cracks of Smekal tracks may account for the difference in the actual and theoretical values of adsorption potential and diffusion. Again adsorption is sometimes accompanied by swelling. Activation of adsorbents consists essentially of removal of impurities

(causing increase in adsorption), increase of surface (formation of single crystals), and development of cracks. It is rational to express adsorption per unit surface rather than per unit mass of adsorbent and these are not always identical. Kinetics and energetics of adsorption at different temperatures should be carefully studied. At low temperatures owing to slow vibrations, molecules are held atom by atom to the adsorption centres while with rise in temperature some linkages break away. This accounts for difference in adsorption.

55. Conductometric studies of stearic acid hydrosols : Part II.

M. P. VENKATARAMA IYER and B. SANJIVA RAO, Bangalore.

Stearic acid sols offer one of the simplest and at the same interesting systems, which can be studied electrometrically, and conclusions drawn regarding the nature of the interfacial layer and reactions at interfaces. In continuation of the work described by one of us (*Proc. Indian Science Congress, 1932 : J. Mys. University, 1932*) we have carried out measurements of the conductivity of Stearic acid sols and its variation with dilution. Conductometric titrations of the sol against Sodium and Barium hydroxides respectively have also been carried out. The results fully support the theory proposed by the author in previous papers (*J. Ind. Chem. Soc.*, 8, 613, 1931; *J. Mys. University, loc. cit.*) that the 'adsorption theory' with modifications involving 'deformation' of ions can satisfactorily explain all observed facts.

56. Mechanism of the clarification of muddy water by strychnos potatorum seed-paste.

B. SANJIVA RAO and K. SUBBARAMIAH, Bangalore.

Clarification of water by the paste from the seeds of *Strychnos potatorum* has usually been attributed to the proteins in the seeds. Investigations by the authors show that the proteins merely sensitize the suspension and that the actual precipitation is effected by the actions of the alkaloid.

57. The E.M.F. of the system $\text{Hg}/\text{HgO}/\text{Std. Ca}(\text{OH})_2$.

K. SUBBARAMIAH and B. SANJIVA RAO, Bangalore.

The E.M.F. of the above system has been shown to be steady and reproducible and to have the value $0.2023-0.00035(t-30)$ with respect to the N-Hydrogen electrode. It is offered as a convenient standard alkaline electrode for the potentiometric estimation of copper ions in Bordeaux mixture.

58. Investigations on Vitamin C.

A. R. GHOSH and B. C. GUHA, Calcutta.

The content of Vitamin C (ascorbic acid) in different Indian food-stuffs has been determined by the titration technique with 2 : 6-dichlorophenol-indophenol. Pineapple, liches, and red pepper appear to be the richest sources.

Experiments have been carried out on the production of Vitamin C *in vitro* from carbohydrates in the presence of the tissues of the rat. Some carbohydrates appear to show specific behaviour in this respect.

59. Studies on flavins from ox-kidney and *mator* (*Pisum Arvense*).

H. G. BISWAS and B. C. GUHA, Calcutta.

Attempts have been made to isolate a flavin from ox-kidney (renoflavin) and one from *mator* (*Pisum Arvense*) by employing methods, developed by Kuhn. Both the flavins have physiological activity, in that they can promote growth in young Vitamin B₂-deficient rats. The order of activity has, however, not yet been finally determined.

60. The biological oxidation of inositol.

N. DAS and B. C. GUHA, Calcutta.

Studies on the oxidation of inositol by the brain, kidney, heart muscle, and liver tissues of the rat were carried out. The Barcroft-Warburg microrespirometer was used and the tissues were suspended in a mixture of phosphate buffer at pH 7.4 and Ringer-Locke solution. Inositol was found to be oxidized by all the tissues. The rate of respiration with liver tissue was the lowest.

61. Vitamin A in Indian fish-liver oils.

A. R. GHOSH and B. C. GUHA, Calcutta.

Further studies on the above subject indicate some disparity between the biological and tintometric values of some Indian fish-liver oils.

62. Dyes derived from phenanthraquinone.

P. C. DUTTA and DAMODAR PRASAD, Muzafferpur.

6-Chloro-3,4-tolylene diamine (Morgan and Drew, *J.C.S.*, 1920, 117, 784) was condensed by the authors with various derivatives of phenanthraquinone and thereby yellow or brown azine dyes obtained (*Proc. Indian Science Congress*, 1934). In the azine dyes, the chromophoric property of the azine ring is enhanced by the change of a nitrogen atom from the trivalent to the pentavalent condition or in other words by the conversion of the azine to an azonium compound. The present communication deals with compounds of the flavinduline type obtained by condensing 6-chloro-3-phenyl-3,4-tolylene diamine (Morgan and Jones, 1921, 119, 191) with phenanthraquinone and its various derivatives in acetic acid solution in presence of conc. hydrochloric acid. As expected, these compounds are all much deeper in colour than similar compounds of the azine type. The 2-amino-phenanthraquinone condensed product is a violet dye and most of the other compounds are deep chocolate in colour. These compounds dissolve in conc. sulphuric acid with a pink colour.

63. Studies in indigoid dyes. Part VIII. 1 : 8-peri-naphthathiophene-phenanthrene-indigos.

P. C. DUTTA, Muzafferpur.

The author has been studying the relation between colour and chemical constitution of the naphthathiophene-phenanthrene-indigos. 1 : 2-, 2 : 1-, and 2 : 3-naphthathiophene-phenanthrene-indigos have already been described in parts II, IV, and VI respectively (*Ber.*, 1933, 66, 1226; *ibid.*, 1934, 67, 5, 1319). The present paper deals with 1 : 8-peri-naphthathiophene-phenanthrene-indigos obtained by condensing 1 : 8-naphthoxy-penthiophene with phenanthraquinone and its various derivatives and completes all the possible naphthathiophene-phenanthrene-indigos.

Unlike the isomerides already described, these compounds are slightly soluble in alkaline hydrosulphite vat and as such the shades obtained on cotton are rather light. The 2-aminophenanthraquinone condensed product dyes cotton in pure green shade from the vat and the other compounds mostly in violet shade.

64. Studies in indigoid dyes.

S. K. GUHA, Patna.

It has been shown by Guha (*J. Ind. Chem. Soc.*, 1933, 10, 679) and Guha and Mullik (*ibid.*, 1934, 11, 395) that 5-methyl-3-hydroxy-thionaphthene (Auwers and Arndt, *Ber.*, 1909, 42, 541) reacts readily with aromatic 1 : 2 diketones such as acenaphthenequinone, isatin and their various derivatives and phenanthraquinone, giving rise to beautiful indigoid vat dyes which impart a deeper shade on wool as well as on cotton than those of the corresponding compounds obtained from 3-hydroxy-thionaphthene (cf. Bezdziak and Friedlander, *Monatsh.*, 1908, 29, 306 and 376; Guha, *J. Ind. Chem. Soc.*, 1932, 9, 423). This paper describes the preparation and properties of more of indigoid compounds obtained from 5-methyl-3-hydroxy-thionaphthene and various aldehydes such as glyoxal, *p*-chlorobenzaldehyde, anisaldehyde, piperonal, vanillin, cinnamaldehyde, protocatechuic aldehyde, *m*-nitrobenzaldehyde, *p*-hydroxybenzaldehyde, *p*-dimethyl-aminobenzaldehyde, and *m*-aminobenzaldehyde (cf. Auwers and Arndt, *loc. cit.*).

65. Dyes derived from acenaphthenequinone. Part V. Indigoid vat dyes.

S. K. GUHA, Patna.

Friedlander and Woroshzow (*Annalen*, 1912, 388, 1) observed that of the four naphthothiophene-indigos, the bis-1 : 8-derivative is pure blue. This led the author to think that if 1 : 8-naphthothiooxypenthiophene could be condensed with acenaphthenequinone and its various derivatives, the resulting naphthopenthiophenacenaphthylene indigos might possess deep colour. With this object in view 1 : 8-naphthooxypenthiophene (Friedlander and Woroshzow, *loc. cit.*) was condensed with acenaphthenequinone, 3-chloro-, 3-bromo-3-methoxy and its 3 : 4-dinitro derivative only. The expectations have not been realised. These compounds are deep red substances. The analogously composed phenanthraquinone derivative has also been obtained which is dark chocolate.

66. The estimation of phenylmercaptan.

BALWANT SINGH, ANAND SARUP, and H. B. DUNNICLIFF, Lahore.

Copper sulphate has been used as a reagent to estimate phenyl mercaptan in benzene solution. For comparison the amount of phenyl mercaptan in the benzene solution was also determined by treatment with mercuric chloride (Sampey and Reid, *J. Amer. Chem. Soc.*, 1932, 54, 3404). The acid liberated in each case was titrated with a standard solution of sodium hydroxide and the end point determined by a conductometric method.

67. Studies on optical activity and chemical constitution. Optically active acids and bases. Part I. The condensation products of *m* and *p*-amino dimethylanilines with camphorquinone.

MAHAN SINGH and H. B. DUNNICLIFF, Lahore.

p-Dimethylaminophenylimino-camphor has very high rotatory power. In aniline it is $(\alpha)_D^{20} = 3000^\circ$ and $(\alpha)_{5780} = 3344^\circ$. This value

exceeds those of the compounds prepared by Forster and Thornley (*J.C.S.*, 1909, 95, 942), Singh and Singh (*J.C.S.*, 1921, 119, 789), and Patel and Guha (*J.I.C.S.*, 1934, 9, 987), though the compound under discussion does not possess the essentials of these compounds. This remarkable effect of the dimethylamino group has also been recorded by Betti (*Gazzetta Chim. Ital.*, 1923, 53, 424) in the condensation product of *α*-naphtholbenzylamine with *p*-dimethylaminobenzaldehyde.

While the rotations of acids and bases fall or are reversed in sign when they are ionized, the rotation of dimethyl-amino hydrochloride in ethyl alcohol is $(\alpha)_D = -53^\circ$ while that of the base is $(\alpha)_D = 2436^\circ$. This compound is both thermotropic and phototropic.

m-Dimethylaminophenylimino camphor has $(\alpha)_D = 711^\circ$ (aniline).

68. Studies on optical activity and chemical constitution.

Optically active acids and bases. Part II. The condensation products of *o*-, *m*- and *p*-aminodimethylanilines with camphoric anhydride.

MAHAN SINGH and H. B. DUNNICLIFF, Lahore.

o-Dimethylaminocamphoranilic acid (m.p. 153°) has a very small positive rotation. The dimethylamino group is known to have a depressing effect in the *o*-position (cf. Rule and co-workers, *J.C.S.*, 1926, 553, 2116; 1928, 178; 1929, 401, 2274). This substance is an optically active amino acid, in which three phases are possible; the ionized carboxylate, the free amino acid and the ionized amino compound. The substance was therefore examined, first in the presence of an equivalent amount of alkali and secondly with an equivalent amount of hydrochloric acid. It has a slight + rotation in a neutral medium, which increased very little when alkali was added, but $(\alpha)_D$ rose to 55.5° when an equivalent weight of the acid was present; (cf. *d*-aspartic acid behaves similarly).

The dimethylamino group in the *p*-position produces an exaltation but not to the extent that was expected. *p*-Dimethylamino camphoranilic acid (m.p. 193°) obeys the simple dispersion formula of Drude $\alpha = \frac{k}{\lambda^2 - \lambda_0^2}$ but the rotatory dispersion of the *o*-dimethylaminocamphoranilic acid is complex.

69. The physical identity of enantiomers. Part I. Rotatory dispersion of enantiomeric borneols, camphors, camphoric acids, sodium camphorates and camphoric anhydrides.

B. K. SINGH and INDRAMANI MAHANTI, Cuttack.

Last year a preliminary account of the work was given. The authors have now made a complete study of the rotatory dispersion of *l*-borneol in ethyl alcohol and benzene, *d*- and *l*-camphor in ethyl alcohol, benzene and acetone, *d*- and *l*-camphoric acid in ethyl alcohol, acetone and water, *d*- and *l*-sodium camphorate in water, and *d*- and *l*-camphoric anhydride in ethyl alcohol and chloroform for 10 different wavelengths ($\lambda = 4358$ to 6709). They have shown that the claim of Campbell (*J. Amer. Chem. Soc.*, 1930, 26, 560; 1931, 53, 1661) that there are differences in the numerical values of the rotatory power of *d*- and *l*-camphoric acids, cannot be substantiated. On the other hand, they find that there are no differences in the rotatory power of optically active and opposite forms. It is clear that the samples with which Campbell worked were impure.

Another case of *d*- and *l*-mandelic acid which is also cited by Campbell as not obeying Pasteur's Law of Molecular Dissymmetry has been shown by Körtüm (*Ber.*, 1931, 64B, 1506) to be due to impure samples of the acids. With the satisfactory removal of discrepancies noticed in the case of mandelic and camphoric acids, it may now be asserted that Pasteur's Law of Molecular Dissymmetry rests on sound experimental basis.

70. Synthetical experiments on Genkwanin and Wogonin.

K. C. GULATI and K. VENKATARAMAN, Lahore.

Bharadwaj and one of the writers have shown that 5-hydroxy-flavones can be prepared by the action of aluminium chloride on the 5-methyl ether; a new synthesis of tectochrysin was carried out by this method. The writers have now found that by the regulated action of aluminium chloride chrysin dimethyl ether and tectochrysin can be directly prepared from 2 : 4 : 6-trimethoxydibenzoylmethane. An alternative route to chrysin dimethyl ether has been found in the action of sodamide on 2-benzoyloxy-4 : 6-dimethoxyacetophenone. The synthesis of genkwanin (5 : 4'-dihydroxy-7-methoxyflavone) and wogonin (5 : 7-dihydroxy-8-methoxyflavone) by means of these reactions is nearing completion.

71. The constitution of bilobetin.

K. C. GULATI, H. S. MAHAL, and K. VENKATARAMAN, Lahore.

Comparison of the properties of 3 : 7 : 4'-trihydroxyflavone, prepared by the Robinson reaction, with those of demethylbilobetin has revealed their non-identity, a conclusion also arrived at by Furukawa by degradation experiments on the natural substance. The correctness of Furukawa's suggestion that bilobetin is a methyl ether of 5 : 8 : 4'-trihydroxyflavone is being tested by synthesis of the 5 : 8-dihydroxyflavone type. After unsuccessful attempts to prepare 2-hydroxy-3 : 6-dimethoxyacetophenone, we have resorted to the conversion of 5-benzeneazo-8-hydroxyflavone through the obvious stages to 5 : 8-dihydroxyflavone.

72. Antiseptics and anthelmintics: the naphthalene analogue of thymol.

K. B. SEHRA and K. VENKATARAMAN, Lahore.

1-Methyl-4-isopropyl-3-naphthol, being a derivative of thymol and of β -naphthol, may be anticipated to have interesting physiological properties and progress towards its synthesis is described. Thymol methyl ether, succinic anhydride and aluminium chloride gave 2-methyl-4-methoxy-5-isopropyl-benzoylpropionic acid; Clemmensen reduction yielded the γ -phenylbutyric acid, which did not undergo ring closure to the ketotetrahydronaphthalene. Alternative processes, such as the action of aluminium chloride on 1-methyl-3-naphthyl isopropyl ether, are being investigated. The paper includes the preparation of certain new antiseptics derived from trichlorophenol, tribromophenol and β -naphthol.

73. The action of sodamide on *o*-acyloxyacetophenones.

D. C. BHALLA, H. S. MAHAL, and K. VENKATARAMAN,
Lahore.

It has been shown by two of us elsewhere (*Current Science*, 1933) that 2-acetyl-1-naphthyl benzoate in ether is smoothly converted by sodamide at room temperature to 2-benzoylacetyl-1-naphthol, closure of which to α -naphthylflavone can be effected by the usual methods.

In view of the significance of this observation for determining the course of the Robinson reaction and for the synthesis of natural colouring matters of the flavone group, we have studied the action of sodamide on the *o*-acyl derivatives of numerous other ketones, such as *o*-hydroxyacetophenone, 1-acetyl-2-naphthol, *w*-methoxyresacetophenone and 2-phenylacetyl-1-naphthol; the acyl derivatives included the acetyl, benzoyl, anisoyl and cinnamoyl. The behaviour was of four types: (1) no reaction took place and the original ketone was recovered; (2) the diketone was produced; (3) the product was the 2-hydroxy-2 : 3-dihydro- γ -pyrone; (4) the chromone was directly obtained.

74. Detergency of soap solutions.

B. G. ACHARYA and T. S. WHEELER, Bombay.

The object of the work is to determine the amount of soap absorbed by cotton from dilute solutions of neutral soaps prepared from various oils and fats. From the relative absorption of various soaps on yarns, the exact concentration and temperature at which a particular soap has its maximum detergency is deduced. On addition of varying amounts of soap-builders, like sodium carbonate, tri-sodium phosphate, sodium silicate, and borax to different soap solutions, the amount of absorption by the yarns is noted and from the data the exact proportion of the builder giving the maximum scouring effect is deduced. Further the effect of absorption by the addition of sodium chloride is also studied.

Surface-tension, viscosity and pH measurements are being carried out with the above solutions to see if a relation exists between the absorption values and these properties.

75. The reactions of acetophenone-piperonal.

R. P. DODWADMATH and T. S. WHEELER, Bombay.

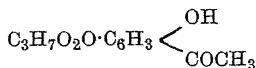
The above chalkone was oxidised by means of H_2O_2 in presence of an alkali to the *oxide* (m.p. 97-8°) which reacts with methyl alcohol in presence of H_2SO_4 to give a *methoxy-compound* (m.p. 117-8°) and with ethyl alcohol to give an *ethoxy-compound* (m.p. 93-4°). The oxide condenses with NH_2NH_2 to give a *hydrazone* (m.p. 172-3°), which further changes to a *pyrazole* (m.p. 194-5°). On boiling the methoxy compound with a few drops of aqueous alkali a *diketone* (m.p. 111-3°) is obtained which condenses with *o*-phenylene-diamine to give a *quinoxaline-compound* (m.p. 136-8°). The oxide with alcoholic alkali is converted into a *glycollic acid* (m.p. 149-50°), the diketone being first formed. The chalkone also gives a *dibromide* (m.p. 153-4°) and a *tribromide* (m.p. 172-3°). The dibromide when boiled with methyl alcohol gives a *monobromo-monomethoxy-compound* (m.p. 115-6°) and with ethyl alcohol gives a *monobromomonoethoxy-compound* (m.p. 143-4°). Similarly a *monochloro-monomethoxy* and a *monochloro-monoethoxy compound* (m.p. 118-9°) have been prepared. A *trichloride* (m.p. 127-8°) of the chalkone has been isolated.

Similar reactions have been carried out with acetophenonenitro-piperonal.

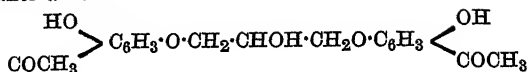
76. Condensation of glyceryl chlorhydrin with resacetophenone.

D. R. NADKARNI and T. S. WHEELER, Bombay.

Two products, a *mono-ether*



and the other a *di-ether*



were obtained from the above condensation. The latter was confirmed by preparing it from epichlorhydrin which also gave the *glycide ether* under different conditions.

These ethers condense with several aldehydes to give the respective *chalkones* of which the *tri-bromo derivatives* give on hydrolysis *bromo-flavones*; the *di-bromo* obtained from the *acetoxy-chalkones* also give *flavones*.

The chalkones from the mono-ether give *flavonols* with 6% hydrogen peroxide in 30% yield, while those from the di-ether give only with 30% hydrogen peroxide.

77. Condensation of benzotrichloride with nitranilines.

A. P. KHANOLKAR and T. S. WHEELER, Bombay.

Benzotrichloride was condensed with *p*-nitraniline in nitrobenzene and *di*-(*p*-nitro-phenyl) benzamidin, m.p. 191° was obtained in the form of its hydrochloride. Its acetyl and benzoyl derivatives have m.p. 181-83° and 198° respectively. With chloro-formic ester a compound of m.p. 168° was obtained. With benzanilideimidochloride it gave a compound m.p. 142-144°. On oxidation with H₂SO₄ and KMnO₄ it gave a compound m.p. 234-235° of which the probable constitution is [C₆H₅C(: NC₆H₄NO₂) (·NC₆H₄NO₂)₂].

A similar condensation was obtained with *m*-nitraniline and the same reactions carried out with the product obtained. *o*-nitraniline also gave a condensation product but the yield was small.

The synthesis of di-(*p*-nitro-phenyl)benzamidin from benz-*p*-nitraniline imido chloride and *p*-nitraniline is being effected.

78. Condensations of benzotrichloride.

S. P. JOSHI *and* T. S. WHEELER, Bombay.

s-Tribromophenol on condensation with benzotrichloride yields a compound (m.p. 102°) insoluble in acids and alkali, which appears to have the constitution: $C_{19}H_{10}O_3Br_8$. Further work is in progress. *p*-Chloroaniline on condensation with benzotrichloride in nitrobenzene as medium yields *di(p-chlor-phenyl)-benzamidine* (m.p. 142°) as the *hydrochloride*. It has been *acetylated* and *benzoylated*. *s*-Tribromoaniline similarly gives an *amidine* (m.p. 192°-93°).

79. Kinetics of heterogeneous organic reactions: the reactions between organic halogen compounds and solid inorganic salts.

M. V. NABAR and T. S. WHEELER, Bombay.

It has been found that ethyl ether inhibits the reaction between benzyl chloride and silver nitrate, the effect being quite apparent when 2% of ether is added to benzyl chloride.

The rate of reaction is proportional to the quantity of silver nitrate and to the concentration of benzyl chloride in the mixture of benzyl chloride and ether. In other words the reaction occurs at the surface of the silver nitrate and not throughout the solution.

Carbon tetrachloride decreases the rate of reaction but not to the same extent as ether. The presence of water greatly decreases the rate of reaction.

80. Effect of inhibitors on the benzoin reaction.

B. F. FERREIRA and T. S. WHEELER, Bombay.

The action of various inhibitors on the benzoin reaction is being studied. Sulphur is found to be the most powerful, 1 part in 20,000 being sufficient to produce a marked depression in the normal yield. Carbon bisulphide also inhibits the reaction but to a lesser extent, 1 part in 200 being sufficient to lower the normal yield.

The curves obtained are of the same type as those obtained with pure potassium cyanide, with this difference, however, that a diminished quantity of KCN appears to be functioning in the heterogeneous reaction. The homogeneous autocatalytic reaction is unaffected.

It is intended to try the effect of other inhibitors like H_2S , SO_2 , and organic compounds of sulphur.

81. Kinetics of the benzoin reaction in the presence of solvents.

P. S. REGE and T. S. WHEELER, Bombay.

Previous work in this laboratory on the kinetics of the reaction has been extended to a study of the effect of solvents. Toluene and chlorobenzene have been found to act as inhibitors. The results can be explained on the assumption that they precipitate potassium cyanide from its solution in benzaldehyde. Ethylene glycol has a marked accelerating effect.

82. Reactivity of formic acid.

L. S. HEBLE and T. S. WHEELER, Bombay.

It has been found that anhydrous formic acid reacts with compounds containing a reactive halogen atom replacing it with a hydroxyl group and forming HCl and CO. Benzotrichloride and benzal chloride treated in this way are converted quantitatively to benzoic acid and benzaldehyde respectively. Reaction also occurs with benzyl chloride but the reaction is slow except in presence of zinc chloride. Acetyl chloride reacts violently at ordinary temperature with formic acid, and benzoyl chloride somewhat more slowly. The reaction can be applied to the quantitative estimation of reactive halogen, the hydrogen chloride evolved being absorbed in silver nitrate.

83. Some reactions of 2-phenyl-4-hydroxy-3-carbethoxy-quinoline.

R. C. SHAH and V. R. HEERAMANBECK, Bombay.

2-Phenyl-4-hydroxy-3-carbethoxy-quinoline, obtained through the condensation of benzanilide-imido-chloride, and sodio-ethyl-malonate was hydrolysed to the free acid, and this has been smoothly decarboxylated to the known 2-phenyl-4-hydroxyquinoline, m.p. 254° , by heating with water in a sealed tube at $210-220^\circ$. Heating at a lower temperature ($160-170^\circ$) with water gives a compound, m.p. $218-220^\circ$, which appears to be a dimorphic modification of 2-phenyl-4-hydroxy-quinoline.

• Action of phosphorus pentachloride on the carbethoxy-quinoline gives the corresponding 4-chloro-derivative, m.p. $101-103^\circ$, in which the chlorine atom is shown to be mobile by its ready conversion by hydrolysis into 2-phenyl-4-hydroxy-quinoline-3-carboxylic acid.

It is found that the carbethoxyquinoline does not give a colouration with alcoholic ferric chloride nor does it absorb bromine. It is, therefore, concluded that it has the ketonic constitution of 2-phenyl-3 : 4-dihydro-3-carbethoxy-4-quinolone.

Ethylation by sodium ethoxide and ethyl iodide gives a C-ethyl derivative, m.p. $226-228^\circ$, whose constitution as 2-phenyl-3 : 4-dihydro-3-ethyl-3-carbethoxy-4-quinolone follows from the fact that it is identical with the

compound obtained through the condensation of benzanilide-imido-chloride with the sodium compound of ethyl-malonic ester. Methylation in a similar manner gives the C-methyl derivative, m.p. 165-166°.

84. Chemistry of imido-chlorides. Part V. Reaction of benzanilide-imido-chloride with aromatic tertiary amines. Geometrical isomerism in the amidines.

R. C. SHAH and R. V. SHAH, Bombay.

Shah, Despande, and Chaubal made the observation that benzanilide-imido-chloride reacts at a higher temperature with dimethylaniline and diethylaniline to give crystalline bases $C_{20}H_{18}N_2$ (m.p. 148-150°) and $C_{21}H_{20}N_2$ (m.p. 150°) respectively, the condensation taking place at the nitrogen atom with the elimination of alkyl halide.

The constitutions $\text{Ph}-\text{C} \begin{smallmatrix} \nearrow \text{NPh} \\ \searrow \text{N}-\text{Me} \\ \quad \text{N}-\text{Ph} \end{smallmatrix}$ and $\text{Ph}-\text{C} \begin{smallmatrix} \nearrow \text{NPh} \\ \searrow \text{N}-\text{Et} \\ \quad \text{N}-\text{Ph} \end{smallmatrix}$ were assigned

to the two compounds, which, however, were found to be not identical with the products obtained from benzanilide-imido-chloride and monomethylaniline and monoethylaniline respectively. The non-identity was provisionally explained as being due to geometrical isomerism due to $\text{C}=\text{N}$ linkage.

The study has been continued and it has been found that benzanilide-imido-chloride reacts with dimethylaniline at a lower temperature to give the oily base, identical with the one obtained from monomethylaniline; whereas at higher temperatures, it gives the solid isomer, m.p. 148-150°. At intermediate temperatures a mixture of the oily and solid isomers is obtained and a method has been worked out for the complete separation of the isomers. It thus appears that the oily base is first formed and then undergoes isomerisation to the solid base at a higher temperature.

The constitution assigned to the solid base, m.p. 148-150°, from benzanilide-imido-chloride and dimethylaniline has been confirmed by hydrolysis with concentrated hydrochloric acid in a sealed tube at 150-160°, when the products obtained were identified as benzoic acid, aniline, and monomethylaniline. It is thus definitely proved that both the solid

and the oily bases have the same constitution $\text{Ph}-\text{C} \begin{smallmatrix} \nearrow \text{NPh} \\ \searrow \text{N}\cdot\text{MePh} \end{smallmatrix}$ and the

isomerism must, therefore, be geometrical isomerism as suggested before. The observation is of great interest as this is the first case of geometrical isomerism in the amidines.

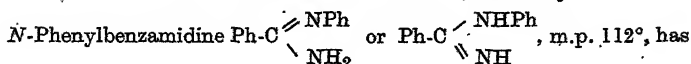
85. Chemistry of imido-chlorides. Part VI. Reaction of benzanilide-imido-chloride with monohydric phenols in the presence of anhydrous aluminium chloride: A synthesis of hydroxybenzophenones.

R. C. SHAH and M. C. LAIWALLA, Bombay.

In continuation of previous work of one of the authors (Shah, *Proc. Indian Science Congress*, Bombay, 1934) the authors have condensed benzanilide-imido-chloride with phenol in the presence of anhydrous aluminium chloride. The product obtained in good yield, is the anil of *p*-hydroxybenzophenone which hydrolyses readily by aqueous alcoholic hydrochloric acid to give the free ketone. This provides a convenient method for the preparation *p*-hydroxybenzophenone. The study is being extended to cresols and substituted phenols.

86. Chemistry of imidochlorides. Part VII: derivatives of *N*-phenylbenzamidine.

R. C. SHAH and H. P. GHADIALI, Bombay.



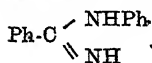
been previously prepared in poor yields (about 20%) by shaking a solution of benzanilideimidochloride in petroleum ether with concentrated aqueous ammonia.

The amidine has now been prepared in about 80% yield by a modified method, in which a solution of benzanilideimidochloride in dry ether is added to an excess of methyl alcoholic ammonia. With an excess of ben-

zanilide imidochloride, the dicondensation product $\text{Ph}-\text{C} \begin{array}{l} \nearrow \text{NPh} \\ \searrow \text{NH}-\text{C} \begin{array}{l} \nearrow \text{Ph} \\ \searrow \text{NPh} \end{array} \end{array}$

M.P. 174° which is new, is obtained.

Several reactions of the amidine have been studied, including those with benzaldehyde, phenylisocyanate, urethane, and α -naphthylisocyanate, and chloroacetic ester and definite crystalline products isolated in all cases. In most of these the amidine appears to react in the form



Acetyl and benzoyl derivatives of the amidine have been prepared and the action of dehydrating agents on these will be studied in the expectation of converting them into derivatives of 4-methyl and 4-phenyl-quinazolines.

87. C-Alkyl Resorcinols. Part V. A new and simple synthesis of rhizonaldehyde.

R. C. SHAH and B. V. SAMANT, Bombay.

Rhizonaldehyde, 2-hydroxy-4-methoxy-3 : 6-dimethylbenzaldehyde, which is related to rhizonic acid, a lichen acid, —2-hydroxy-4-methoxy-3 : 6-dimethyl benzoic acid, has been previously synthesised from β -orcinol, 2 : 5-dimethyl-resorcinol itself obtained from *p*-xylicene through a number of stages (Sönn, *Ber.*, 1916, 49, 2589; Robertson, *J.*, 1930, p. 313, Pfau, *Helv. Chim. Acta*, 1928, 2, 864).

The authors have now achieved a simple synthesis of rhizonaldehyde directly from orcinol. Orcylaldehyde, prepared from orcinol, when methylated by KOH and CH_3I under special conditions, undergoes nuclear methylation and directly gives rhizonaldehyde, m.p. 136° . Sönn and Pfau give m.p. 136° . It gives a reddish brown colouration to alcoholic ferric chloride.

88. C-Alkyl Resorcinols. Part IV. Synthesis of Poly-Alkyl Resorcinols.

R. C. SHAH and P. R. MEHTA, Bombay.

In continuation of previous work, already reported to the Chemistry Section of the Indian Science Congress, Bombay (1934), the authors have synthesised some more poly-alkyl resorcinols. 4 : 6-diethyl resorcinol did not undergo the Hoesch reaction to give the 2-acetyl derivative, but the preparation of the corresponding aldehyde, 3 : 5-diethyl-2 : 6-dihydroxy-benzaldehyde could be achieved, and this on reduction by the Clemmensen method gave 4 : 6-diethyl-2-methyl-resorcinol.

Orsacetophenone was reduced similarly to give 4-ethyl-5-methyl resorcinol. Hoesch reaction on the latter gave 4-ethyl-5-methyl-2 : 4-dihydroxy acetophenone which was characterised by the formation of the phenylhydrazone and the oxime. Clemmensen reduction of this ketone led to 4 : 6-diethyl-5-methyl resorcinol.

5-Ethyl-6-methyl-2 : 4-dihydroxy-benzaldehyde, prepared from 4-ethyl-5-methyl-resorcinol, gave on reduction 4-ethyl-5 : 6-dimethyl resorcinol.

4-6-Diethyl-5-methyl-resorcinol, was converted into the aldehyde, 3 : 5-diethyl-4-methyl-2 : 6-dihydroxy-benzaldehyde, and this by Clemmensen reduction afforded 4 : 6-diethyl-2 : 5-dimethyl-resorcinol, a tetra-alkyl resorcinol.

The various alkyl resorcinols have been characterised by the formation of acetyl or *p*-nitrobenzoyl-derivatives, and those with a free position, *ortho* to the hydroxyl group, have been condensed with acetoacetic ester and malic acid by the Pechmann method to give coumarins.

89. A direct synthesis of 3-bromo-2-methoxybenzoic acid.

N. W. HIRWE and B. V. PATIL, Bombay.

Conditions have been investigated and the 3-bromo-2-methoxybenzoic acid has been successfully obtained by direct bromination.

90. Study of chloral-bromo-salicylamides.

N. W. HIRWE and B. V. PATIL, Bombay.

Chloral is condensed with the various bromo-salicylamides and its methyl ethers, such as (1) 3-bromo-salicylamide; (2) 5-bromo-salicylamide; (3) 3 : 5-dibromo-salicylamide; (4) 3-bromo-2-methoxybenzamide; (5) 5-bromo-2-methoxybenzamide; (6) 3 : 5-dibromo-2-methoxybenzamide. Reactions of these condensation products with various reagents such as (1) dimethylsulphate; (2) acetic anhydride; (3) benzoylchloride, etc. have been investigated.

91. Study of chloral-nitro-salicylamides.

N. W. HIRWE and MISS K. D. GAVANKAR, Bombay.

Chloral is condensed with various nitro-salicylamides and its methyl ethers, such as (1) 3-nitro-salicylamide; (2) 5-nitro-salicylamide; (3) 3 : 5-dinitro-salicylamide; (4) 3-nitro-2-methoxybenzamide; (5) 5-nitro-2-methoxybenzamide; (6) 3 : 5-dinitro-2-methoxybenzamide. Reactions of these condensation products with various reagents such as (i) dimethyl sulphate; (ii) acetic anhydride; (iii) benzoyl chloride, etc. have been investigated.

92. Interaction of sulphuryl chloride with acid aryl amines.

D. R. SUKHATANKAR and G. V. JADHAV, Bombay.

Benzanilide is condensed with sulphuryl chloride in the presence of dry benzene, when benz-4-chloro-anilide is obtained: The work has been extended to benz-*o*, *m*, *p*-toluidides and benz-*p*-aniside and chloro-derivatives obtained.

93. Derivatives of hydroxy-naphthoic acid.

S. N. RAO and G. V. JADHAV, Bombay.

In continuation of the work described before the acid chlorides of 4-chloro- and 4-bromo-acids have been prepared and various derivatives are made from them.

94. Experiments on the synthesis of paraberine. Part I. A synthesis of 8 : 17-diketo-6 : 17-dihydroparaberine.

S. N. CHAKRAVARTI and K. GANAPATHI, Chidambaram.

In order to throw some light on the reason why an angular structure like that of berberine is so commonly selected by nature and to test the validity of the suggestion that straight linear structures are more difficult to synthesise, the synthesis of paraberine was attempted. For this purpose β -naphthaquinone was first converted into isocoumarin-carboxylic acid, and the latter condensed with benzylamine. The benzylamine condensation product on treatment with aluminium chloride in nitrobenzene solution gave 8 : 17-diketo-6 : 17-dihydro-paraberine. All attempts to reduce the diketo compound to tetrahydroparaberine have so far been unsuccessful, but the problem is being further investigated.

In the second scheme, dibenzylketone was converted into its oxime, and the oxime reduced electrolytically to the amine. Attempts to convert the amine into compounds containing the four condensed rings of paraberine, by the action of formaldehyde or formic acid and subsequent treatment were unsuccessful, doubtless due to the absence of activating *p*-methoxy groups.

95. Chemical investigation of Indian medicinal plants.
Part IV. Preliminary chemical examination of *Teramnus Labialis*.

S. N. CHAKRAVARTI and K. GANAPATHI, Chidambaram.

A systematic analysis of the entire plant, which is used as a cure for consumption, fever, and disorders of wind, bile and blood, has been made. The active principle of the plant appear to be a glucosiden acid, and two substances, m.p. 83° and 129°. These latter substances have been isolated in pure state. During working up of large quantities of the plant material, it was found that the nature of the active principles collected in different seasons differed. The physiological and pharmacological action, as well as the constitution of the active principles isolated, are under investigation.

96. Experiments on the synthesis of peri-quinolineazol (N-N).
Part I. Attempted synthesis of tetrahydroperi-quinolineazol (N-N).

S. N. CHAKRAVARTI and K. GANAPATHI, Chidambaram.

Attempts were made to synthesise peri-quinolineazol (N-N) which contains a fused quinoline and pyrazole nuclei, as such a synthesis has an intrinsic interest of its own, and as such a ring system was assumed to be present in cyttisine by Eurins. For this purpose *N*-aminodihydrocarbostyryl was (i) condensed with formaldehyde, (ii) converted into its formyl derivative, but attempts to cyclise these products were unsuccessful. Next *N*-aminodihydro-carboxyryl was converted into the benzoyl derivative, m.p. 168-169°. The benzoyl derivative on treatment with phosphorus oxychloride gave a substance, m.p. 212°.

Further experiments are in progress.

Quinoline-8-carboxylic acid, a starting substance for one of the schemes for synthesis, has been obtained in excellent yields by the oxidation of 8-methoxyquinoline with chromium trioxide and sulphuric acid.

97. *o*-Aldehydocarboxylic acids. Part II. A synthesis of 4-methoxyphthalaldehydic acid and a new synthesis of opianic acid.

S. N. CHAKRAVARTI and M. SWAMINATHAN, Chidambaram.

By the application of the new method of synthesis of *o*-aldehydocarboxylic acids recently discovered by us, 4-methoxyphthalaldehydic acid and opianic acid have been synthesised.

5-Methoxyhomophthalic acid was oxidised in boiling xylene solution by means of selenium dioxide to 4-methoxyphthalonic acid. The aniline derivative of 4-methoxyphthalonic acid, m.p. 165°, was then transformed into anilino-4-methoxy-phthalaldehydic acid, m.p. 179-180°, and the latter hydrolysed to 4-methoxyphthalaldehydic acid, m.p. 141°. This acid gives an oxime and was reduced to 5-methoxyphthalide, m.p. 119°.

3 : 4-Dimethoxyhomophthalic acid which had previously been obtained as an oil by Haworth, Koepfli and Perkin was obtained in a crystalline state, m.p. 116°, and oxidised to the corresponding phthalonic acid. The aniline derivative, m.p. 156°, was then converted into anilino-opianic acid, m.p. 187-188°, and the latter hydrolysed to opianic acid, m.p. 150°.

98. A new synthesis of 3 : 11-dimethoxy-oxyprotoberberine and a synthesis of 2 : 3 : 11 : 12-tetramethoxy-oxyprotoberberine.

S. N. CHAKRAVARTI and M. SWAMINATHAN, Chidambaram.

With the object of confirming the constitution of 3 : 11-dimethoxy-tetrahydroprotoberberine, 3 : 11-dimethoxyprotoberberine was synthesised in the following manner :—*N*- β -*m*-methoxyphenyl-ethyl-5-methoxyhomophthalimide, m.p. 133°, prepared from 5-methoxyhomophthalic acid and β -*m*-methoxyphenylethylamine, was converted by hydrolysis into the corresponding amic acid, m.p. 167°. When the methyl ester (m.p. 85°) of this acid was treated with phosphorus oxychloride it gave a substance, m.p. 143°, identical with 3 : 11-dimethoxy-oxyprotoberberine previously obtained by Chakravarti, Haworth and Perkin from 3 : 11-dimethoxy-tetrahydroprotoberberine.

The method employed in the synthesis of 2 : 3 : 11 : 12-tetramethoxy-oxyprotoberberine was similar to that outlined above. 5 : 6-dimethoxyhomophthalic acid condenses with β -veratrylethylamine to yield *N*- β -veratrylethyl-5 : 6-dimethoxyhomophthalimide, m.p. 180° which on careful hydrolysis is converted into *N*- β -veratrylethylhomophthalamic acid, m.p. 165°. The methyl ester of this is converted in good yield by the action of phosphorus oxychloride into a substance, m.p. 190-191°, with properties characteristic of a compound of the oxyberberine type. This substance was found to be identical with 2 : 3 : 11 : 12-tetramethoxy-oxyprotoberberine obtained from 2 : 3 : 11 : 12-tetramethoxy-tetrahydroprotoberberine, and hence the constitution of the latter is confirmed.

99. Formation and transformation of carbon ring compounds. Part II.

S. C. SEN-GUPTA, Calcutta.

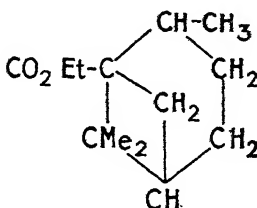
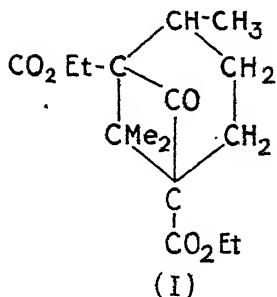
The anhydride of cyclopentane-carboxy-1-acetic acid condensed with toluene in presence of aluminium chloride giving cyclopentane-1-toluy-1-acetic acid (m.p. 150°). This keto-acid on reduction by the Clemmensen method gave cyclopentane-1-(*p*-methyl)benzyl-1-acetic acid (m.p. 69°), which on cyclisation with sulphuric acid gave 1-keto-1 : 2 : 3 : 4-tetrahydro-7-methylnaphthalene-3 : 3-spiro-cyclopentane (b.p. 141-144°/5 mm.). Selenium dehydrogenation of this spiro-compound at 300-350° gave 3-methylphenanthrene instead of the expected 2-methylphenanthrene and β -methylantracene.

100. Studies in bridge formation. Part I. Syntheses of ketopinanedicarboxylic ester and pinane carboxylic ester.

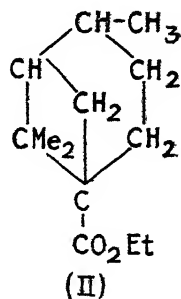
R. C. DAS GUPTA and P. C. GUHA, Bangalore.

In continuation of the work described in last year's abstract on the syntheses of ethylketoapopinane dicarboxylic ester (*Proc. Indian Sc. Cong.*, 1934, No. 113, p. 32), it has now been found that the disodium derivative of ethyl ketonorpinate reacts with α -dibromobutane in a mixture of benzene and alcohol (3 : 7) and at high temperature to yield two products: (a) ethyl ketopinanedicarboxylate (I), b.p. 118–120°/12 mm., and (b) bromoisobutyl-ketonorpinic ester, b.p. 68–72°/20 mm., the latter only giving a pinkish coloration with ferric chloride.

Ethyl ketopinanedicarboxylate during reduction with zinc amalgam and concentrated hydrochloric acid suffers partial hydrolysis and decarboxylation (*cf. J.C.S.*, 1923, 123, 3145) and yields pinane carboxylic ester (II), b.p. 150–152°/27 mm. Replacement of the carboxy group by hydrogen leading to the formation of pinane itself is being tried.



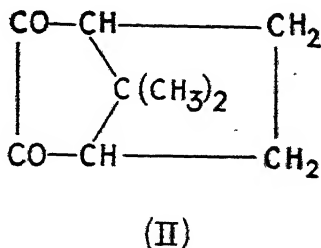
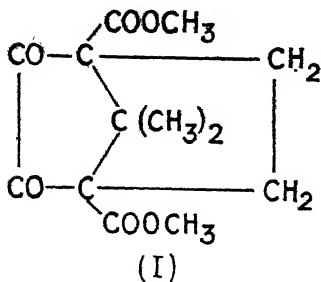
or



101. Studies in bridge formation. Part II. Attempts to synthesise bicyclic terpenes of the camphane group.

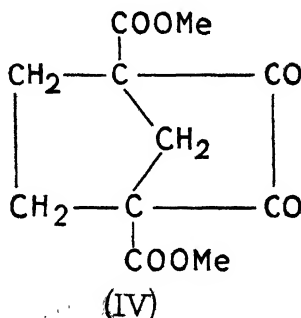
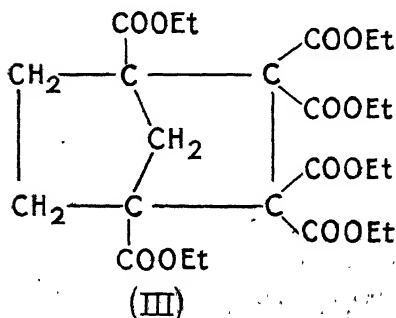
P. C. GUHA and S. K. RANGANATHAN, Bangalore.

The di-sodium derivative of dimethyl diketeoapocamphorate was expected to give the bicyclic ester (I), on treatment with ethylene bromide. The ester (I), on hydrolysis and decarboxylation should yield apocamphorquinone (II), a substance as yet unknown.



The di-sodium compound of dimethyl diketoapocamphorate gave, on being heated in a sealed soda water bottle with ethylene bromide, in benzene or methyl alcoholic medium a beautiful crystalline ester, melting at $163.5-164.5^\circ$. Although, analytical values agreed with that of (I), no derivative of it has as yet been prepared. On hydrolysis, the ester gave a dicarboxylic acid, m.p. $274-275^\circ$ (decomp.). The ester on being heated with dilute hydrochloric acid at about 170° gave a solid which was identified to be 1 : 1-dimethylcyclopentane-3 : 4-dione (J.C.S., 1911, 99, 2012).

The (i) condensation of disodio-ethyl-ethane tetracarboxylate with ethyl $\alpha\alpha'$ -dibromo-*cis*cyclopentane-1 : 3-dicarboxylate and (ii) a Dieckmann-Komppa reaction on methyl-*cis*-cyclopentane-1 : 3-dicarboxylate with methyl oxalate, have each yielded oily products which are being further studied. The former reaction is expected to give the bicyclic ester (III) and the latter the bicyclic diketonic ester (IV).



102. Studies in bridge formation. Part III.

K. N. GAIND and P. C. GUHA, Bangalore.

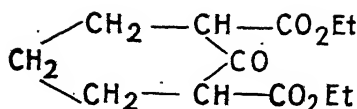
In an attempt to bridge methyl cyclohexane-2 : 3-dione-1 : 4-dicarboxylate (I) (J. Indian Inst. Sci., 1932, 15A, 125) in which there are two hydrogen atoms replaceable by sodium and attached to the two *para* carbon atoms, with carbonyl bromide, two interesting products melting respectively at 210° and 145° have been obtained. The former is crystallised from alcohol-benzene mixture, while the latter from dilute alcohol. The molecular weight determination and combustion values of the former prove it to be compound (I) bridged by CO in position 1 and 4. The latter is being further studied. Bridging of (I) with chloroacetyl, methylene iodide, etc. is being tried.

Hydrolysis and decarboxylation of compound (I) by heating with dilute hydrochloric acid under pressure at about 120° has yielded cyclohexane-2 : 3-dione, m.p. 98.5° .

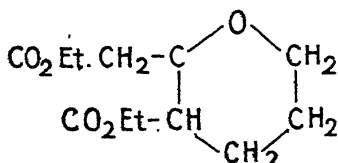
103. Studies in bridge formation. Part IV. Action of alkylene dibromides on acetone dicarboxylic ester.

P. C. GUHA and N. K. SESHADRIENGAR, Bangalore.

The sodium derivative of acetone dicarboxylic ester reacting with trimethylene bromide was expected to give a cyclohexanone derivative, having two replaceable hydrogen atoms in 2 : 6 positions.



The reaction was carried out in dry *benzene* suspension by heating under pressure for nearly 100 hours at 140° – 50° in soda water bottles. From the petrol soluble portion of the reaction product (about half of the whole) on hydrolysis a di-basic acid was isolated, m.p. 172° , the corresponding mono-acid mono-ester had m.p. 83° . A similar reaction conducted by Perkin (*J.C.S.*, 1887, 51, 739) in absolute *alcohol* medium gave a product to which the following structure was given:



To this di-basic acid Perkin gives m.p. 185 – 92° and to the corresponding mono-acid mono-ester the m.p. 115° . These observations being obviously interesting, a thorough examination of the reaction products under the two sets of conditions (including our petrol insoluble portion) is being made.

104. Studies in bridge formation. Part V. Ring formation with carbonyl bromide.

P. C. GUHA and N. K. SESHADRIENGAR, Bangalore.

Mono-sodium derivative of malonic ester (2 mols.) reacts with trimethylene bromide, under modified conditions, to give a 50% yield of ethyl pentane-tetracarboxylate (1 : 1 : 5 : 5), Perkin's method giving only 15%. The disodium derivative of this reacts with carbonyl bromide to give *cyclohexanone*-2 : 2 : 6 : 6-tetracarboxylic ester (I) which on hydrolysis and decarboxylation by heating with 50% sulphuric acid for 16–20 hours over a free flame, gives *cyclohexanone*, identified through its typical derivatives. Alcoholic potash hydrolyses the tetra-ester to a tetra acid, m.p. 246° ; anilide m.p. 315° . Work is in progress for the conversion of the tetra-acid into the 2 : 6-dicarboxylic acid and the corresponding di-ester.

The disodium derivative of ethyl butanetetracarboxylate reacts similarly with carbonyl bromide to give ethyl *cyclopentanone*-2 : 2 : 5 : 5-tetracarboxylate, which on drastic hydrolysis and decarboxylation gives *cyclopentanone*, characterized through its semicarbazone.

105. Studies in bridge formation. Part VI. Attempts to synthesise bicyclic terpenes of the thujane group.

P. C. GUHA and N. K. SESHADRIENGAR, Bangalore.

cycloHexanone-2 : 6-dicarboxylate, b.p. 140 – $2^{\circ}/1.25$ mm. prepared from ethyl pentane-1 : 1 : 5 : 5-tetracarboxylate according to the method of Ushakov (*J. Russ. Phy. Chem. Soc.*, 1929, 61, 795; cf. *Current Science*, 1934, 3, 20) forms in ethereal solution a di-sodium derivative which

gives with bromine, under the separation of sodium bromide, an oily product b.p. 130-32°/1.25 mm. Its difference from the original *cyclohexanone*-2 : 6-dicarboxylic ester is proved from its boiling point and non-formation of sodium derivative. The bridged product gives with phenylhydrazine a derivative, m.p. 182°, as distinct from the corresponding derivative of the original *cyclohexanone* ester, m.p. 152-153°. Work is in progress for the conversion of the bridged *cyclohexanone* ester into the corresponding bridged hydrocarbon as also for the preparation of 3-methyl-*cyclohexanone*-2 : 6-dicarboxylate starting from methyl-trimethylene bromide and malonic ester.

106. Studies in bridge formation. Part VII. Attempts to synthesise bicyclic terpenes of the carane group.

P. C. GUHA and T. N. GHOSH, Bangalore.

By the action of bromine (2 atoms) on the disodium derivative of succinylidimalonic ester, ethyl *cyclohexan*-3 : 6-dione-1 : 1 : 2 : 2-tetracarboxylate has been obtained which, on hydrolysis by alcoholic potash in the cold, gives the corresponding tetra-acid in very poor yield. Work is in progress to convert the tetra-acid by decarboxylation into the dibasic acid, the ester of which, due to the presence of two reactive hydrogen atoms in 1 : 2-positions, will, it is expected, form the starting material for the synthesis of bicyclic terpenes of the carane group.

The reaction between the disodium derivative of succinylidimalonic ester and methylene iodide, carried out in toluene solution at 120-130°, yields a crude ester which, on hydrolysis by potash in the cold, yields in poor yield an acid in brilliant shining needles, m.p. 133-34°. Attempts are being made to improve the yield of the acid.

107. Studies in steric hindrance. Part VII. Nitration of brominated cinnamic acids and their esters.

P. RAMASWAMI AYYAR and J. D. VASAVADA, Bangalore.

Nitration of the following compounds has been studied under comparable conditions : (i) *cis*- and *trans*- α -bromo-cinnamic acids and their methyl esters ; (ii) *cis*- and *trans*- α - β -dibromo-cinnamic acids and their methyl esters ; and (iii) α β -tri-bromo- β -phenyl propionic acid and its methyl ester. The steric hindrance of the side-chain on position (2) of the nucleus in these compounds is found to increase progressively as shown by the fact that while about 35% *ortho*-nitration takes place in compounds of (i) above, no *ortho*-nitro-derivative could be isolated in the case of (ii) compounds ; while appreciable quantities of *meta*-nitro-derivative are formed in the case of (iii) compounds. The *para*-nitro-derivative is throughout the main by-product.

108. Studies in steric hindrance. Part VIII. Oxidative elimination of the carboxyl group in 3 and 4-nitro-phthalic acids with simultaneous replacement by a phenolic group.

P. RAMASWAMI AYYAR and J. D. VASAVADA, Bangalore.

Oxidation with acetone-permanganate of 3-nitro-phthalic acid yields a fair percentage of 3-nitro-salicylic acid (m.p. 146°), while 4-nitro-phthalic acid gives a similar yield of 5-nitro-salicylic acid. The eliminated carboxyl group is either *ortho* or *para* to the nitro group, and an explanation for this is given on the polarity theory.

109. Studies in geometrical isomerism. Part III. The isomeric *cis* and *trans* α -bromo-ortho-nitrocinnamic acids.

P. RAMASWAMI AYYAR and J. D. VASAVADA, Bangalore.

The *trans* compound (m.p. 211-212°) is long known, but the *cis* isomer (m.p. 159°) has now only been prepared by (i) nitration of *cis*- α -bromo-cinnamic acid; and (ii) the action of pyridin or alcoholic potash on *o*-nitro-cinnamic acid dibromide. From a chloroform solution containing traces of free bromine the *cis* isomer is quantitatively precipitated as the *trans* compound (m.p. 211-212°) by exposure to direct sunlight for a few minutes.

110. Studies in steric hindrance. Part V. The bromination of *o*-nitrotoluene.

P. RAMASWAMI AYYAR and D. R. MEHTA, Bangalore.

Using the following catalysts, iron, iron and iodine and antimony pentachloride in succession nearly 60% of 4-bromo-derivative and 40% of the 6-bromo-derivative of *o*-nitrotoluene are formed, whereas under comparable conditions chlorination yields 67% of the 6-chloro-derivative. This difference is attributed to the greater bulk of the bromine atoms and the consequent steric hindrance.

111. Studies in steric hindrance. Part VI. Condensation of *m*-nitrophenol with formaldehyde.

P. RAMASWAMI AYYAR and D. R. MEHTA, Bangalore.

The cyclic methylene ether $C_8H_7O_4N$ (m.p. 77°) of 2-hydroxy-6-nitrobenzyl alcohol (i.e. of 6-nitro-salicyl-alcohol) has been obtained in this reaction and this yields on oxidation 6-nitro-salicylic acid (m.p. 167°).

112. Acid chlorides and thio-esters of 3-nitrophthalic acid.

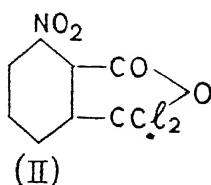
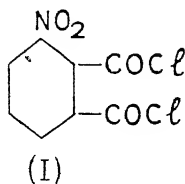
G. C. CHAKRAVARTI and N. K. SESHADRIENGAR, Bangalore.

3-Nitrophthalic anhydride and phosphorus pentachloride were ground together and heated in an oil bath under reflux at 140-145° for 5 hours and then $POCl_3$ removed under suction. The residue on being successively crystallised from CCl_4 and petrol gave the acid chloride (I) m.p. 77-78°, yield 65%.

Asymmetrical form.—The other acid chloride (II) was prepared from (I) according to the method given in Organic Synthesis, Vol. XI, p. 88 and crystallised from petrol, m.p. 124-25°.

p-Tolyl-, phenyl-, benzyl-mercaptans were condensed with 3-nitrophthalyl chloride (I) in anhydrous benzene solution and in each case a product consisting of a solid and a thick viscous liquid were obtained, of which the former ones on crystallisation from alcohol gave the following thio-esters: tolyl, m.p. 134-135°; phenyl, m.p. 105-106°; benzyl, m.p. 85°. The liquid fractions could not be purified by distillation as they decompose on heating.

The same thio-esters are formed from the mercaptans and 3-nitrophthalic anhydride in presence of P_2O_5 .



113. Condensation of esters of β -aryl-glutaconic acids with aromatic aldehydes.

G. R. GOGTE, Bangalore.

The β -aryl glutaconic acids contain a reactive methylene group. Consequently, the glutaconic esters from anisole, *o*-cresol-methyl ether, and *p*-cresol-methyl ether have been found to condense with benzaldehyde, anisaldehyde, etc. in presence of alcoholic potash to give the corresponding benzyldiene glutaconic acids. The compound from anisole glutaconic acid and benzaldehyde melts at 213° (decomp.) and that with anisaldehyde at 164° (decomp.), while the compound from *o*-cresol-methyl ether glutaconic acid and benzaldehyde melts at 202° (decomp.) and that with anisaldehyde at 162° (decomp.).

114. Geometrical isomerism in β -aryl-glutaconic acids.

G. R. GOGTE, Bangalore.

The β -(2-methoxy-naphthyl-3-)-glutaconic acid has already been separated in its geometrically isomeric forms (*Proc. Indian Acad. Sci.*, 1934, 1, 57). It has now been observed that, on warming the *cis*-variety, m.p. 162° (decomp.), with dilute sodium hydroxide solution, an equilibrium mixture of the *cis* and *trans* forms is obtained, containing about 60 per cent. of the latter, m.p. 186° (decomp.). On the contrary, the *trans* variety is transformed into its *cis* isomer completely on being refluxed with strong solution of sodium hydroxide. β -(1-Methoxy-naphthyl-4-)-glutaconic acid, m.p. 199° (decomp.) (*ibid.*, p. 56) was similarly transformed into another form, m.p. 188° (decomp.), and the former has been proved to be the *cis*, and the latter to be the *trans* variety. The *cis* β -(1-methyl-naphthyl-2-)-glutaconic acid, m.p. 161° (decomp.), prepared (*ibid.*, p. 54) was transformed into the *trans* variety, m.p. 152° (decomp.).

The glutaconic acids with the β -positions occupied by groups like anisole, *o*-cresol-methyl ether, *p*-cresol-methyl ether, etc. did not lend themselves to similar transformation. Thus the capacity of β -aryl glutaconic acids to exhibit geometrical isomerism seems to depend upon the volume of the radical occupying the β -position. Consequently glutaconic acids, where the β -position is occupied by heavy radicals, have been prepared from the coumaryl-4-acetic acids by hydrolysis and benzylation, and they have been shown to exist in two forms.

115. Extension of Michael's Reaction. Part VI.

T. N. GHOSH, Bangalore.

In part IV (Ghosh and Guha, *J. Indian Chem. Soc.*, 1934, 11, 355; cf. *Proc. Indian Science Congress*, 1934, Chemistry Abstracts, p. 237, Nos. 132, 133) it has been shown that a tricyclic compound is obtained by condensing ethyl $\alpha\alpha'$ -phenylcarbamylacetone dicarboxylate (I) with an aldehyde ($R\cdot CHO$). The work has been extended to study the effect of the group (R) on the formation of the tricyclic ring. It is found that the tricyclic ring is obtained when R is phenyl, nitrophenyl, $C_6H_4(OCH_3)$ or $(Ph\cdot CH=CH)$. If, however, the ester (I) is condensed, under exactly similar conditions, with formaldehyde or acetaldehyde, the cyclobutane ring is obtained. It is, therefore, evident that the formation of the tricyclic ring from the cyclobutane ring is conditioned by the atomic volume of the group (R).

Ethyl acetonedicarboxylate reacts with α -naphthyl-isocyanate to yield a piperidine compound, instead of the open-chain dinaphthylcarbonyl derivative analogous to compound (I). The piperidine derivative reacts with aldehydes to give bridged compounds.

116. Analysis of Indian coal tars and their dist

B. J. HEGDE, B. SANJIVA RAO, and P. C. G

A fresh sample of thin coke over tar received fi gr. at 15.5°. 1.2171) gave the following percentage under standard conditions :—110°, 2.5; 110–170°, 23.0–270°, 7.6; 270–350°, 17.6; above 350°, 5.2; pit the previous sample sent at our request was not a r (*Proc. Ind. Sci. Cong.*, 1932, 19, 221).

117. Studies in bridge formation. Part V
synthesise santene glycol.

B. H. IYER and P. C. GUHA, Bai

The action of methylene bromide and *paraform* diacetyladipeate was tried under various experimenta object of getting 1 : 3-diacetyl-cyclopentane-1 : 3- due to the formation of resinous products from which could be isolated, these methods had to be aband magnesium methyl iodide on the diacid chloride o dicarboxylic acid is being studied and the expectec be subjected to pinacone reduction.

118. Synthesis of some local anæsthetics.

K. N. GAIND, Bangalore.

Fourneau (*Bull. Soc. Chim.*, 1909, (iv) 5, 229–2 derivative of the methyl ester of dimethylamir acid and found it to be a very potent anæsthetic but very irritating to the tissues. With the hope of : ing effect, attempts are being made to esterify the h groups by different aromatic acids and alcohols. T the benzyl *o*- and *m*- tolyl esters have already been

Similar other compounds of higher aliphatic $\text{Me}_2\text{N}\cdot\text{CH}_2\cdot\text{CH}_2\cdot\text{C}(\text{OH})(\text{CO}_2\text{H})$ are prepared and th anæsthetics studied.

119. Formation of heterocyclic compoun
thoxythioacetylcarbamic acid.

T. N. GHOSH, Bangalore,

Dicarbethoxythioacetylcarbamic acid (I) 1933, 164, 107) reacts readily with phenylhydraz to give rise to 1 : 2 : 4-triazole and pyrazol With 4-substituted thiosemicarbazide, it yie ve in which there is a carbonyl-bridge in an aromatic amine with the compoun -membered heterocyclic compound (as) which in presence of alcohol a pyrimidine derivative. The at this particular reaction is r , compound (I) yields a benzine

Formation of the above carbamic acid suggests that t oy the wandering of either nitrogen or to t

of Reformatsky's reaction. Part I. Action of malonate on acetone.

B. H. IYER, Bangalore.

malonate reacts with acetone in presence of zinc, forming a cyclic compound obtained from this with sodium ethylate, on hydrolysis with alkali, gives a semicarbazone, m.p., 133-34°. The ester gives a crystalline product (m.p., 133-34°) and is supposed to be a lactonic acid; its investigation.

Reaction of halogen compounds on oxalodiglycolic ester,

P. C. GUHA, Bangalore.

Reaction of oxalodiglycolic ester does not react with alcoholic suspension even when heated to 130-40° action product on being worked up yielded only the

the same reaction is conducted in benzene suspension, viz. 2 : 5-endoxy-2 : 5-dicarbethoxy-1 : 6-ene (m.p. 165°) is obtained. This compound does not decolourise bromine water. On hydrolysis, it gives a compound agreeing in composition with the acid. Work is in progress for obtaining the endoxy-ene from the above ester as also the condensation of compounds upon oxalodiglycolic ester.

Chemical examination of the roots of *Aristolochia Indica* Part III. The essential oil.

by GAO, B. L. MANJUNATH, and K. N. MENON, Bangalore.

The essential oil for a systematic chemical examination was found to consist mainly of sesquiterpinoid compound *Ishwarone*, $C_{15}H_{24}$, (b.p., 104-105°/1 mm.;

n_D^{30} 1.5015; $[\alpha]_D^{30}$ -42.37°;

128-130°/1 mm.), a ketone *Ishwarone* $C_{15}H_{22}O$, (b.p.,

n_D^{30} 1.5122; $[\alpha]_D^{30}$ -46.47°;

p-nitrophenyl hydrazone: m.p., 186.5°; 2 : 2 (m.p. 167.5°), and an alcohol *Ishwarol*, $C_{15}H_{24}O$

n_D^{30} 1.5098; $[\alpha]_D^{30}$ in alcohol -7.29°;

Reaction of camphor was also isolated. Attempts were made to prepare a suitable derivative of the formyl active hydrogen atom which are being investigated.

123. Chemical examination of the roots of *Aristolochia Indica* (Linn), Part IV. The bitter principles.

P. R. KRISHNASWAMY, B. L. MANJUNATH, and S. SIDDAPPA, Bangalore.

The isolation of two bitter principles from the roots of *Aristolochia indica* has already been reported. The present paper deals with a preliminary chemical study of them.

The first of these is a yellow, crystalline compound of the formula $C_{17}H_{11}O_7N$. This is insoluble in acids and possesses feeble acidic properties as evidenced by the formation of a monosodium salt. Its physical and chemical characteristics correspond to those of the substances of a similar nature, isolated by Pohl and others, and Hesse (*Arch. Pharm.*, 1895, 233, 284), and is isomeric with *aristolochic acid* (m.p., 215°). It has, therefore, been named *iso-aristolochic acid*.

A very careful examination showed that this was the only yellow bitter principle present in the roots. The paper contains some of the results of the chemical study of the compound.

The second substance is a colourless phenolic alkaloid, the isolation of which has already been reported (*Proc. Ind. Sci. Congress*, 1933, 210). When crystallised from toluene, it melted with decomposition at 158.9° . This material dissolved readily in methyl alcohol, but separated out soon; it could then be crystallised only from a large volume of methyl alcohol, when it was obtained in the form of long needles melting sharply at 215° . The analytical results correspond to the formula $C_{17}H_{15}O_8N$, showing a close relationship with the bitter principle. So far, it has not been possible to prepare any crystalline derivatives, excepting the hydrochloride (m.p., 265°).

Further work is in progress.

124. On the occurrence of acids with uneven number of carbon atoms in vegetable oils and fats.

U. S. KRISHNA RAO, B. L. MANJUNATH, and S. SIDDAPPA, Bangalore.

Gerard (*Compt. rend.*, 1880, 111, 305) was the first to claim to have isolated an acid with uneven number of carbon atoms, i.e. Daturic acid $C_{17}H_{34}O_2$ from the oil of the seeds of *Datura Stramonium*. Since then a few acids of similar nature are said to have been obtained by various workers from different vegetable sources. A considerable amount of work questioning the above results is found recorded in the literature.

A systematic investigation of the oil from *Datura Stramonium* showed that the solid acids consisted only of palmitic and stearic acids with a small amount of lignoceric acid. No trace of daturic acid could be detected.

From the oil of *Butea Frondosa* Katti and Manjunath (*J. Indian Chem. Soc.*, 1929, 6, 839) isolated 2 fractions of acids corresponding to the formulae $C_{23}H_{46}O_2$ and $C_{25}H_{50}O_2$. These could not be resolved by either chemical or physical means. Evidence is now presented to show that they are also eutectic mixtures of acids with even number of carbon atoms.

125. The structure of isopsoralen.

H. S. JOIS and B. L. MANJUNATH, Bangalore.

isopsoralen $C_{11}H_6O_3$ (m.p., $141-142^\circ$) obtained from the seeds of *Psoralea corylifolia* (*Proc. Indian Science Congress*, 1934, p. 243, Abstract No. 157) is also found to belong to the class of coumarino-cumarones. The opening up of the coumarin ring and the formation of *methoxyisopsoralic acid* $C_{12}H_{10}O_4$ (m.p., 142°) by methylation has already been reported.

The reduction of *isopsoralen* by sodium amalgam results in the formation of *dihydro isopsoralic acid* $C_{11}H_{10}O_4$ (m.p., 124-125°) which lactonises only on heating to *dihydroisopsoralen* $C_{11}H_8O_3$ (m.p., 74-75°). Both these compounds on oxidation with nitric acid give succinic acid. This definitely establishes the presence of the coumarin ring in the molecule, accounting for 2 of the oxygen atoms. The absence of a hydroxyl or methoxy group points to the rest of the molecule as consisting of a cumarone ring. Further proof of its structure as the result of oxidative degradations is offered.

The substance is in all probability identical or isomeric with *angelicin* isolated by Späth and Pesta from the roots of *Angelica archangelica* (Ber. 1934, 67, 853).

126. Studies on the preparation of starches from various grains and tubers.

H. P. DAS GUPTA, Bangalore.

Rice Starch.—Rice powder, which has been passed through 100 mesh sieve, is steeped in 0.5% caustic alkali for 48 hours and stirred at intervals. The whole suspension is then diluted until it attains a particular pH value and centrifuged. Two layers separate, the bottom one being about 97% pure (on moisture free basis), while the purity of the top layer is 92%. A number of cheap varieties of rice have been investigated as sources for the manufacture of rice starch.

Juar Starch (Sorghum vulgare).—Juar is steeped in very dilute sulphurous acid and ground in the wet condition when it softens. It is then passed through a fine sieve and allowed to stand overnight. Two layers are easily separated, the bottom one being mostly starch. The layers are treated with different concentrations of dilute caustic alkali. A starch of about 95% purity is obtained.

Ragi Starch (Eleusine coracana).—Although ragi contains a considerable amount of colouring matter which interferes with the preparation of starch, a clean white preparation can nevertheless be obtained by the method used. Ragi is ground wet and after passing through a fine sieve, allowed to stand overnight. The supernatant liquid is drained off and a dilute caustic alkali is used for the removal of protein and other undesirable materials. The starch obtained is approximately 96% pure.

Sathi Starch (Curcuma zedoaria Roscoe).—*Curcuma zedoaria* grows wild in the low lying tracts of Bengal and in many parts of the west coast. The starch prepared out of it has a high viscosity comparable with that of potato starch and can usefully replace the latter which is now being imported in considerable quantities from abroad for use in the textile industry. The starch is prepared from the tubers by grinding the dried chips and passing through a fine sieve. This powder is steeped in water and allowed to stand till it settles at the bottom. The supernatant liquid is syphoned off. The starch is separated by lixivation. The dried product is approximately 94% pure.

Investigation on the possibilities of other grains and tubers as sources of starch for use in different industries is in progress.

127. Influence of neutral salts on the enzymic hydrolysis of starch.

K. VENKATA GIRI and J. G. SHRIKHANDE, Bangalore.

The effect of neutral salts on the hydrolysis of starch by sweet potato amylase has been studied under varied conditions. The salts accelerate the action of the amylase on the acid side of the optimal pH 6.0 and were without any effect at the optimal pH, and at the alkaline side of the optimal pH at low concentrations. At high salt concentration there

is retardation on the alkaline side of the optimal pH. The neutral salts accelerate the activity at pH below the optimum to an extent increasing with the acidity of the medium. The accelerating effect of the salts in relation to the concentration of the salt, enzyme and substrate has been investigated. The amylase preparations obtained by different methods—by (a) dialysis, (b) precipitation by alcohol, and (c) purification by adsorption on alumina gel displayed the same behaviour towards neutral salts. The anion is more concerned in the reaction than the kation. The accelerating effect is independent of the nature of the kation.

The apparently contradictory results obtained by several workers when studying the influence of neutral salts on the activity of vegetable amylases have been explained in the light of the foregoing observations.

128. A note on the Rideal-Stewart modification of Winkler's method for determining dissolved oxygen in waters.

R. H. RAMACHANDRA RAU, Bangalore.

The figures for dissolved oxygen in waters by the Rideal-Stewart modification were often lower than those by the Winkler method. This was ultimately traced to inadequacy of alkali in the alkaline iodide mixture prepared according to Thresh, Beale, and Suckling ('Examination of Waters and Water Supplies', 1933). As many of the commoner brands of caustic alkali are not quite pure, either the proportion of acid used for oxidation must be reduced or that of the alkaline iodide solution increased.

Work is in progress relating to (i) the conditions for absorption of oxygen by manganous hydroxide, and (ii) correction for reducing matter of the waters by direct reaction with potassium iodide and acid.

129. Examination of wax occurring in sandal leaves.

A. V. VARDARAJA IYENGAR, Bangalore.

It was found that hot alcohol extracts from sandal leaves waxy material which crystallises on cooling. A simple method of isolating it has been worked out. The wax which is yellowish white in colour consists of an acid, a primary alcohol, a secondary alcohol and a paraffin. Further studies on the chemical nature of the wax and relation of this to health and disease are in progress.

130. α -Clausenan and di- α -clausenan.

K. S. SUBRAMANIAN and B. SANJIVA RAO, Bangalore.

The Raman spectra of these compounds have been found and compared with those of some furane derivatives.

131. Santalol.

B. SANJIVA RAO, Bangalore.

The pure santalols have been found to be odourless. The odour has been found to be due to a comparatively volatile oxidation product of the santalols, which can be removed by repeated distillation.

132. Raman spectra of quinoline, quinaldine and isoquinoline.

S. K. K. JATKAR, Bangalore.

The following lines were observed:—

Quinoline: 389 (1), 457 (0), 516 (8), 604 (2), 755 (10), 980 (2), 1028 (5), 1162 (1), 1311 (2), 1368 (10), 1389 (3), 1428 (6), 1568 (6), and 3039 (5).

Quinaldine : 391 (3), 423 (3), 458 (4), 519 (8), 661 (0), 700 (1), 766 (10), 955 (0), 987 (0), 1011 (3), 1145 (0), 1205 (0), 1270 (1), 1312 (3), 1370 (10), 1423 (1), 1465 (2), 1556 (1), 1598 (1), 2923 (1), and 3047 (10).
*iso*Quinoline : 499 (10), 517 (10), 778 (10), 1008 (4), 1030 (5), 1132 (0), 1252 (1), 1278 (2), 1321 (5), 1378 (10), 1428 (5), 1457 (5), 1491 (0), 1551 (2), 1580 (3b), 2448 (0), 2490 (1), and 3047 (8).

The striking similarity of the spectra to those of benzene, pyridine, picolene and naphthalene is discussed.

133. Raman spectra of *cis* and *trans* cyclohexanes and dekalins.

S. K. K. JATKAR, Bangalore.

According to Sachse-Mohr strainless multiplaner ring structure cyclohexane should exist as a chair or cradle form. This hypothesis lacks experimental support. Although it has recently been shown that the transform is the only stable form Huckel has pointed out the small energy difference between the coplaner and multiplaner models as the cause of difficulty in distinguishing among the possible derivatives of the isomers.

Attempt has been made to find evidence for the existence of the two possible forms by studying the Raman effect of pure cyclohexane, (m.p. 6.4°) and the same treated with aluminium chloride as suggested by Zelinski (m.p. -43°). The difference between the two spectra is the complete disappearance of the line $400\text{-}1\text{ cm.}$ in cyclohexane treated with AlCl_3 the other shifts remaining sensibly the same. Search was also made for lines due to possible decomposition products. A similar study of the *cis* and *trans* dekalins did not show appreciable difference between the two spectra.

134. The study of antimony electrode.

D. N. MEHTA and S. K. K. JATKAR, Bangalore.

Using the apparatus described in the *Proc. Indian Science Congress*, 1934, Bombay, the electrode potentials of antimony electrodes with solutions of various pH values have been determined. The value of the potential $\text{Sb/Sb}_2\text{O}_3$ deduced from this has been confirmed by direct measurement against a hydrogen electrode and the temperature coefficient of the system has been determined. The results indicate that the stick antimony electrode whether freshly polished or allowed to tarnish shows a potential corresponding to the formation of antimony tetroxide. The system $\text{Sb/Sb}_2\text{O}_3$ is another possibility of the electrode reaction, which is further supported from the results obtained from experiments carried out on similar lines with bismuth electrodes.

135. Raman spectra of β -pinene and dipentene.

R. PADMANABHAN and S. K. K. JATKAR, Bangalore.

Previous work of the Raman spectrum of β -pinene is confined to the region $14358\text{-}14916$ and there seems to be no data on dipentene at all. In our work we have not only recorded the shifts due to 14046 but also additional frequencies due to the 4358 line. The Raman spectrum of dipentene surprisingly enough seems to have very little resemblance to that of limonene. Since the identification of limonene and dipentene in a mixture is very difficult on account of their close resemblance in physical and chemical properties, this difference in light scattering appears, therefore, to have some practical use in detecting one in presence of the other.

136. The anomalous rotatory dispersion of β -pinene. Part I.

R. PADMANABHAN and S. K. K. JATKAR, Bangalore.

This paper discusses the various possibilities by which one could explain the anomalous rotatory dispersion of β -pinene. (1) It is not due to Cotton effect because there is no evidence of any absorption in the region of the anomaly. (2) In our previous work sabinene had also been found to be anomalous (*Indian Science Congress, Abstracts, 1932*) and since this compound resembles β -pinene in having a semicyclic double bond adjacent to an asymmetric carbon atom it was considered that the anomaly might be due to the superposition of an opposite rotation due to the induced asymmetry of the semicyclic double bond. The absence of any anomaly in camphene, however, shows this hypothesis to be untenable. (3) On prolonged purification by fractional distillation, it is found that there is a gradual transition from a laevorotating substance in the first fractions to a dextrorotatory substance of higher rotatory dispersive power in the tail fractions. The explanation of the anomalous rotatory dispersion would thus appear to lie in the heterogeneous character of the substance. An analysis of the Darmoni diagram reveals a three component system. The anomaly seems to be an inherent characteristic of the β -pinene molecule.

137. Continuous hydrogenation of vegetable oils.

J. G. KANE, Bangalore.

Vegetable oils such as groundnut and cocoanut oils have been hydrogenated with a new nickel catalyst that has been found to be very active and resistant to poisons. The catalyst has been used in a form suitable for continuous operation in plants of varying sizes specially manufactured for the purpose. Thus experiments have been carried out in a glass model on a laboratory scale and on a semi-commercial scale in an all-metal plant fitted up with all the appliances. With the latter plant, the yield of hardened product, m.p. 35° to 40° (from groundnut oil), was 3 lbs. per hour per lb. of nickel, under optimum conditions.

Experiments conducted under varying pressures—20 to 80 lbs. per sq. inch—and temperatures between 120° and 180° show that the above continuous process can be worked economically under a pressure of 60 lbs. per sq. inch and at a temperature range of 120° to 130° .

138. Effect of addition of reagents on the pH of rotary drilling fluids.

D. N. MEHTA, Bangalore.

pH values of tannins from myrobolan powder have been determined by employing bismuth, quinhydrone and antimony electrodes. The effect of addition of sodium hydroxide, hydrochloric acid and tannins (from myrobolan powder) on the pH values of the rotary drilling fluids has been studied hydrogen electrode being used, thereby rationalizing the procedure governing the adsorption of added reagents by rotary drilling fluids.

139. The constitution of vasicin.

K. S. NARANG and J. N. RAY, Lahore.

The Spath structure for peganin is criticised and synthetical experiments are described in support of the structure advocated by Narang and Ray.

140. Synthesis of coumarins and chromones.

D. CHAKRAVARTI, Calcutta.

The condensation of various mono-, di- and tri-hydric phenols with β -ketonic esters shew conclusively that Simonis' reaction is not of general applicability (Chakravarti, *J. Indian Chem. Soc.*, 1931, 8, 129, 407, 619; 1932, 9, 25, 31, 389). It has been observed throughout this investigation that coumarins are always produced using sulphuric acid but phosphorus pentoxide may produce either coumarins or chromones. Excepting in the case of condensation of α -naphthol with unsubstituted acetoacetic ester no other case has been detected where a chromone is formed even in traces using sulphuric acid (*cf.* Dey and Lakshminarayana, *J. Indian Chem. Soc.*, 1932, 9, 149). Attention was, therefore, directed towards the investigation of the part played by phosphorus pentoxide in the formation of chromones as well as towards the possibility of substituting any other condensing agent for phosphorus pentoxide. Thus various acidic, basic and neutral condensing agents, e.g. phosphoric acid, zinc chloride hydrochloric acid gas, sodium ethoxide, boric anhydride, sodium acetate have been tried. It is remarkable to note that if condensation takes place then coumarins are always formed in these cases and all attempts to find a substitute for phosphorus pentoxide have failed.

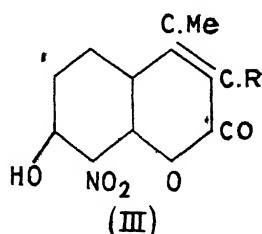
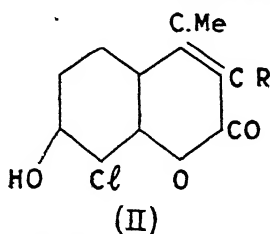
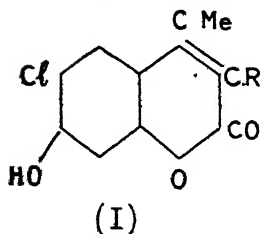
It may also be noted that sulphuric acid in Pechmann's reaction may with advantage be replaced by phosphoric acid particularly in the case of polyhydric phenols, when better yields and purer products are obtained. It has also been found by the author that in Bülow's reaction, which is similar to Pechmann's reaction, the condensation of phenols with β -diketones may also be effected with advantage using sulphuric acid or better phosphoric acid.

141. Constitution of chloro-resorcinol, chloro-resorcylaldehyde and nitro-resorcylaldehyde.

D. CHAKRAVARTI and B. N. GHOSH, Calcutta.

The condensations of halogenated and negatively substituted polyhydric phenols with β -ketonic esters forming substituted coumarins have furnished a ready means for determining the constitution of the substituted phenols and their derivatives.

(2 or 4)-Chloro-resorcinol, prepared according to the method of Reinhard (*J. pr. Chem.*, 1878, 17, ii, 336), condenses with acetoacetic ester and its C-methyl derivative to form 6 or 8-chloro-coumarins (I or II). The nitration of β -methyl-umbelliferone (*cf.* Pechmann and Cohen, *Ber.*, 1901, 34, 666) and 3:4-dimethyl-umbelliferone gives 8-nitro derivatives (III) as they are identical with the condensation products of 2-nitro-



resorcin with acetoacetic ester and its C-methyl-derivative respectively. These 8-nitro-coumarins, on reduction give 8-amino-coumarins, which form stable diazo-anhydrides. The diazo-anhydrides, on treatment with cuprous chloride in hydrochloric acid, give 8-chloro-coumarins which are

different from the condensation products of chloro-resorcinol with the acetoacetic esters, which must therefore, be 6-chloro-coumarins (I). Chloro-resorcinol is, therefore, 4-chloro-resorcinol. A direct synthesis of 6-chloro-coumarins from 6-nitro-coumarins (the condensation products of 4-nitro-resorcin with the acetoacetic esters) is being attempted.

Chloro-resorcinol and 2-nitro-resorcin condense with malic acid to give good yields of coumarins, and it is expected that the formation of coumarins from chloro-resorcyraldehyde and nitro-resorcyraldehyde (Gattermann, *Annalen*, 1907, 357, 313) by their condensation with malonic acid would also settle the position of the substituents in chloro- and nitro-resorcyraldehydes.

142. Synthesis of coumarins from phenols and β -ketonic esters using phosphorus pentoxide. Part III. Coumarins from chloro-resorcinol.

D. CHAKRAVARTI and B. N. GHOSH, Calcutta.

It has so long been supposed that the presence of a halogen atom in the phenolic nucleus greatly hinders Pechmann's reaction in the synthesis of coumarins and the presence of a negative substituent like NO_2 or COOH totally inhibits the reaction (Clayton, *J. Chem. Soc.*, 1908, 98, 2018). It has been found by the authors that even if there be a halogen atom or a negative substituent in resorcinol, which has the faculty of the formation of coumarins with great readiness in Pechmann's reaction, the reaction takes place smoothly forming substituted coumarins. Thus 2-nitro-resorcin condenses with acetoacetic ester and its C-methyl derivative to form coumarins in good yield.

Chloro-resorcin, prepared according to the method of Reinhard (*J. pr. Chem.*, 1878, 17, ii, 336) has been condensed with acetoacetic ester, C-methyl-, C-ethyl-, C-propyl-, C-isobutyl-, C-benzoyl, and α -chloro-acetoacetic esters, acetone dicarboxylic ester, benzoyl acetic ester and aceto-succinic ester in presence of sulphuric acid to give good yields of coumarins. By changing the condensing agent for phosphorus pentoxide in some of these condensations identical coumarins are obtained as is proved by their mixed melting points and also by the identity of their derivatives as was previously observed by one of us (Chakravarti, *J. Indian Chem. Soc.*, 1931, 8, 129, 407).

Condensations of bromo-resorcinol, iodo-resorcinol, resorcylic-carboxylic acid and the negatively substituted orcinol, pyrogallol, *m*-cresol, *p*-cresol, and the naphthols with β -ketonic esters are in progress.

143. Studies in the isoflavone series.

P. C. MITTER and S. MAITRA, Calcutta.

On condensation with hippuric acid, 2 : 4-dimethoxy- β -resorcylic aldehyde gives an azlactone, m.p. 168°, which on hydrolysis gives 2 : 4-dimethoxy-phenylpyruvic acid, m.p. 155°-156°. The oxime of the acid, m.p. 145° was converted by the usual method into 2 : 4-dimethoxy-phenylacetone nitrile, m.p. 75°. On condensation with phloroglucin by Hoesch's method, the nitrile gave phlor-2':4'-dimethoxy-phenylacetophenone, m.p. 175°.

It is proposed to condense the ketone with formic ester and to demethylate the product to 2':4':5:7-tetraoxy-isoflavone.

144. Studies in the anthraquinone series.

P. C. MITTER and P. DUTTA, Calcutta.

3-Nitrophthalic anhydride condenses with phenol in presence of AlCl_3 , the only product of the reaction being 3-nitro-2-(2-hydroxybenzoyl)-benzoic acid, m.p. 238°. On reduction it gives 3-amino-2-(2-hydroxybenzoyl)-benzoic acid, m.p. 217°, which on diazotisation gives 3-hydroxy-

2(2-hydroxybenzoyl)-benzoic acid, m.p. 199°-200°. On ring-closing with fuming sulphuric acid and boric acid, chrysazine is obtained.

3-Nitrophthalic anhydride condenses with anisole at 0° in presence of aluminium chloride. Two products are formed which are separated by fractional crystallisation from methyl alcohol. The main product of the reaction which crystallises from dilute methyl alcohol is 3-nitro-2(4-methoxybenzoyl)-benzoic acid, m.p. 208°. This gives on reduction 3-amino-2(4-methoxybenzoyl)-benzoic acid, m.p. 169°-71°, which on diazotisation gives 3-hydroxy-2(4-methoxybenzoyl)-benzoic acid, m.p. 202°. On ring closure with fuming sulphuric acid and boric acid and subsequent demethylation 1 : 6-dihydroxyanthraquinone, m.p. 270°-72°, is obtained.

The other product of the reaction, which crystallises from methyl alcohol, is most probably 6-nitro-2(4-methoxybenzoyl)-benzoic acid, m.p. 214°.

145. The chemical examination of the seeds of *Nyctanthes arborescens*.

P. S. VARMA and S. K. SHARMA, Benares.

The preliminary examination of the seeds has been carried out and a bitter principle, resin, 2.5% fixed oil, a small percentage of essential oil, sterol, tannins, phlobaphenes, water soluble gums, etc. have been isolated. Work with larger amounts of the material is in progress.

146. Halogenation. Part XIII. Bromination and iodination of *o*-, *m*-, and *p*-xylenes.

P. S. VARMA and K. S. VENKATARAMAN, Benares.

Mono-iodo-xylenes have been obtained before in fairly good yields by the methods worked out in this laboratory (Varma and Kul'karni, *J. Indian Chem. Soc.*, 1926, 3, 291; Varma and Panickar, *ibid.*, 342). Only one di-iodo-*m*-xylene has been obtained before and that by a tedious process (Hammerich, *Ber.*, 1890, 23, 1635; Tohal, Bauch, *Ber.*, 1893, 26, 1105). The authors have succeeded in preparing di-iodo-*o*-xylene and di-iodo-*p*-xylene for the first time in good yields and 4-iodo-6-nitro-*m*-xylene, 2-iodo-5-nitro-*p*-xylene by direct methods.

Bromination of the three xylenes has been more exhaustively studied in (1) sunlight, (2) in sunlight in presence of halogen carriers, and (3) in the dark in presence of halogen carriers. From the results obtained it is clear that in sunlight substitution in side-chain alone occurs whereas with the combined effect of sunlight and the other halogen carriers substitution in both the side-chain as well as in the nucleus takes place. In the dark when only nuclear substitution takes place, the yield of the nuclear products is considerably increased in presence of halogen carriers.

147. Halogenation. Part XIV. Preparation of the mixed halogen derivatives of xylenes.

P. S. VARMA and K. S. VENKATARAMAN, Benares.

* A study of the literature shows that the majority of the mixed halogen compounds of xylenes have been obtained by indirect methods from diamino-compounds by successive replacement of the amino groups by halogens through the Sandmeyer's reaction. A number of mixed halogen compounds, such as 4-chloro-6-bromo-*m*-xylene, 2-chloro-5-bromo-*p*-xylene, 4-bromo-5-iodo-*o*-xylene, 4-bromo-6-iodo-*m*-xylene, 2-bromo-5-iodo-*p*-xylene, 4-chloro-6 (?)iodo-*p*-xylene, 2-chloro-5 (?)iodo-*p*-xylene have been obtained by direct halogenation and some of these compounds, especially the iodo-derivatives have been obtained for the first time.

148. Halogenation. Part XV. Halogenation of *p*-cymene, propyl-benzene and cumene.

P. S. VARMA and M. K. SRINIVASAN, Benares.

p-Cymene has been chlorinated in diffused day-light in presence of halogen carriers as a result of which mono-chloro- and di-chloro-*p*-cymenes have been obtained in varying yields. In the dark, however, only mono-chloro-*p*-cymene has been obtained in varying yields. In sunlight both nuclear and side-chain substituted chloro-derivatives have been obtained. By the direct bromination of 2-chloro-*p*-cymene, 2-chloro-5-bromo-*p*-cymene has been obtained.

When propyl-benzene and bromo-propyl-benzene are directly iodinated in presence of some substances, mono-iodo-, and di-iodo-propyl-benzene and bromo-iodo-propyl-benzene are obtained.

By the study of chlorination and iodination of cumene under different conditions it has been possible to find out the best conditions under which *p*-chloro-cumene, dichloro-cumene, *p*-bromo-cumene, dibromo-cumene, cumene mono-bromide, cumene dibromide, cumene monochloride and cumene dichloride are obtained.

149. Halogenation. Part XVI. Bromination and iodination of mesitylene and pseudo-cumene.

P. S. VARMA and T. S. SUBRAMANIAN, Benares.

Bromination and iodination of mesitylene and iodination of pseudo-cumene have been more exhaustively studied under different conditions in presence of a number of substances and the conditions for getting the best yield of the halogen derivatives determined.

150. Halogenation. Part XVII. Bromination and iodination of diphenyl and benzidine.

P. S. VARMA and M. KRISHNAMURTHI, Benares.

By the direct bromination and iodination of diphenyl, dibromo- and di-iodo-diphenyl have been obtained in good yields. By indirect methods also these bromo- and iodo-compounds have been prepared from benzidine.

151. A new method of preparing organo-mercuric compounds of phenols and aromatic amines. Part II.

PANCHANAN NEOGY and G. K. MUKHERJI, Calcutta.

The work of Neogy and Chatterji (*J. Indian Chem. Soc.*, 1928, 221) has been continued and organo-mercuric compounds of many phenols, nitro-phenols, amines, and nitro-amines have been prepared by the same method with suitable modifications. In this manner α -, β -naphthols, thymol, carvacrol, *o*- and *p*-nitro-phenols as also α -, β -naphthylamines, toluidines, xyldines, anisidine, benzidine, and *o*- and *p*-nitro-anilines have been mercurated.

152. A new method of preparing organo-mercuric compounds of phenols and aromatic amines. Part III.

* PANCHANAN NEOGY and G. K. MUKHERJI, Calcutta.

An interesting observation has been made in the course of the present work that *N*-mercury compounds can be converted to the C-mercury

compounds by dissolving them in dilute hydrochloric acid and subsequently reprecipitating with sodium bicarbonate whereby the mercury atom travels from the nitrogen atom to the nucleus. In this manner C-mercury compounds of aniline, toluidines, xyldines, α -, β -naphthylamines, anisidine, and benzidine have been prepared.

153. Resolution of co-ordinated inorganic compounds into optical isomers. Part III—Tri-propylenediamine compounds of cadmium.

PANCHANAN NEOGY and G. K. MUKHERJI, Calcutta.

Co-ordinated compounds of cadmium containing three molecules of ethylene diamine (Neogy and Mukherji, *J. Indian Chem. Soc.*, 1934, 225) and of zinc (Neogy and Mukherji, contributed to *J. Indian Chem. Soc.*) have been resolved. Attempts to prepare tri-propylene diamine compounds of cadmium have been successful and these are being resolved. Work on this subject is in progress.

154. Chemical examination of the seeds of *Hygrophyla Spinosa*.

N. L. PHALNIKAR, K. S. NARGUND, and D. D. KANGA, Ahmedabad.

The drug belongs to the N.O. Acanthaceæ and is used in jaundice, anasarca and dropsy ; it is also used as a tonic. The powdered seeds were successively extracted with various solvents. The results are indicated in the following table :—

Solvent.	Extract.	Nature of the extract.
1. Petroleum ether (b.p. 40° to 60°).	21%	A pale yellow mobile transparent oil with aromatic odour.
2. Ether ..	1.06%	A dark-red opaque semi-solid mass.
3. Chloroform ..	0.5%	A dark-red liquid. "
4. Alcohol ..	8.87%	Thick resinous mass.

The moisture present in the seeds was found to be 8.43%. The seeds were found to contain both sugar and an enzyme. The following are the constants of the oil from the petroleum ether extract :—

Density at 30° ..	0.9254
$n_D^{33^\circ}$..	1.469674
Iodine value ..	122.1
Saponification value ..	206.5
Acid value ..	2.65
Unsaponifiable matter ..	7.52%
R.M. value ..	0.252
Polenske value ..	0.461

Further work is in progress.

155. Chemical examination of the seeds of *Clitoria ternatea*.

J. D. RAWAL, K. S. NARGUND, and D. D. KANGA, Ahmedabad.

The drug belongs to the N.O. Leguminosæ and is used as a mild purgative and a diuretic.

The powdered seeds were successively extracted with various solvents. The results are indicated in the following table:—

Solvents.	Extract.	Nature of the extract.
1. Petroleum ether (b.p. 40° to 60°).	8.17%	Greenish mobile liquid with bitter smell and taste.
2. Ether ..	1.54%	Dark-red thick liquid.
3. Chloroform ..	1.94%	Greenish thick liquid.
4. Alcohol ..	6.53%	Dark reddish resinous liquid.

The moisture present in the seeds was found to be 6.4%. The following are the constants from the petroleum ether extract.

Density at 30° ..	0.90015
n_D^{33} ..	1.46809
Iodine value ..	80.31
Saponification value ..	205.65
Acid value ..	2.82
Unsaponifiable matter ..	6.906%
R.M. value ..	0.1850
Polenske value ..	0.3701

Further work is in progress.

156. Synthesis of polyhydroxyketones.

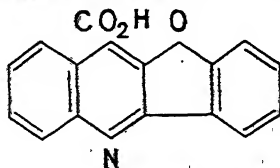
P. K. BOSE and SUNDAR RAM, Calcutta.

Iminochlorides, $\text{PhN} : \text{C}(\text{Cl}) \cdot \text{R}$ readily condense with polyhydroxyphenols in presence of $\text{HCl} \cdot \text{ZnCl}_2$ to form products of the type $\text{R} \cdot \text{C}(\text{NPh}) \cdot \text{R}$ which are easily hydrolysed to the corresponding ketones. The yields are generally good and the method has been found useful for the synthesis of many naturally occurring ketones.

157. Synthesis of atophan analogues.

P. K. BOSE and N. C. GUHA, Calcutta.

Coumaranone condenses with isatic acid in alkaline solution to form



which is structurally similar to atophan. This substance as also its derivatives are expected to possess valuable therapeutic properties.

158. Chloralides. Part II. The condensation of butyl chloral hydrate with α -hydroxycarboxylic acids.

N. M. SHAH, Dharwar.

Recently Shah and Alimchandani (*J. Indian Chem. Soc.*, 1934, 11, 545) have studied the chloralides derived from the condensation of α -hydroxy acids with chloral. But so far as the author is aware, no systematic work has been done with the butyl chloralides. The present investigation has been undertaken to study the butyl chloralides and their properties and compare them with those of simple chloralides.

Tartaric and citric acids have been condensed with butyl chloral hydrate in presence of conc. H_2SO_4 and the condensation products have been studied. The work with other acids on the same lines is in progress.

159. The condensation of ethyl malonate with salicylaldehyde in presence of organic bases.

P. N. KURIEN, K. C. PANDYA, and C. J. PETER, Agra.

Salicylaldehyde has been found (by P. N. K. and K. C. P.) to condense with malonic acid in presence of pyridine alone only when the base is present in traces. Knoevenagel (*Ber.*, 1898, 31, 2593; D.R.P., 97734) has condensed the aldehyde with ethyl malonate with a trace of piperidine.

The same condensation also occurs when traces of other bases are used: viz. pyridine, quinoline, *isoquinoline*, lutidine, naphthoquinoline, quinaldine, cinchonidine, dimethylaniline, and diethylaniline. Conditions of maximum yields (58%) are determined, the product being always ethyl coumarin-carboxylate.

160. Action of acetic anhydride on 2-acetyl-resorcin. A new method for the preparation of γ -resorecylic acid.

D. B. LIMAYE and G. R. KELKAR, Poona.

2-Acetyl-resorcin, m.p. 157° (Limaye and Gangal, *Proc. Ind. Sci. Congress*, 1934; Chemistry Section, p. 229) by the action of acetic anhydride alone is converted into its diacetate, b.p. 175°–180°/10 mm.

In the presence of Na-acetate, however, 2-methyl-3-acetyl-5-hydroxy-chromone ($C_{12}H_{10}O_4$), m.p. 122°, is formed together with its acetate ($C_{14}H_{12}O_5$), m.p. 109°, and a substance melting above 200° which is under investigation.

The constitution of the chromone, m.p. 122°, follows from the products of its easy hydrolysis with caustic alkali, viz. acetone, acetic acid, and γ -resorecylic acid.

This furnishes an excellent preparative method for γ -resorecylic acid as judged from its purity and yield.

161. Synthesis of 3-(*o*-tolyl)-4'-methyl-7':8'-furo-coumarin and of 2-(*o*-toluoyl)-resorcin by the Nidhone process.

S. S. TALWALKAR, Poona.

(Communicated by D. B. Limaye.)

In continuation of Limaye's work on the Nidhone process (*Ber.*, 1932, 65, 375; 1934, 67, 12) the *o*-toluate of 4-methyl-umbelliferone (m.p. 142°) obtained by the action of *o*-toluoyl chloride on 4-methyl-umbelliferone, changes on treatment with aluminium chloride into 4-methyl-8-(*o*-toluoyl)-umbelliferone ($C_{18}H_{14}O_4$), m.p. 242°, which on treatment with bromoacetic ester gives the ethyl ester ($C_{22}H_{20}O_6$), m.p. 145°, of the acid, 4-methyl-8-(*o*-toluoyl)-7-(carboxy-methoxy)-coumarin ($C_{20}H_{16}O_6$), m.p. 208°; which on treatment with acetic anhydride and sodium acetate gives 3-(*o*-toluoyl)-4-methyl-7':8'-furo-coumarin ($C_{19}H_{14}O_5$), m.p. 165°.

The 4-methyl-8-(*o*-toluoyl)-umbelliferone when boiled with alkali yields 2-(*o*-toluoyl)-resorcin, m.p. 119°.

o-Toluic acid and resorcin give 4-(*o*-toluoyl) resorcin ($C_{14}H_{12}O_3$), m.p. 127°, by Nencki's reaction.

162. Synthesis of 3-(*p*-toluoyl)-4'-methyl-7'-8'-furo-coumarin and of 2-(*p*-toluoyl)-resorcin by the Nidhone process.

G. S. SHENOLIKAR, Poona.

(Communicated by D. B. Limaye.)

In continuation of Limaye's work on the Nidhone process (*Ber.*, 1932, 65, 375; *Ber.*, 1934, 67, 12) *p*-toluoyl chloride is condensed with

4-methyl-umbelliferone to give a *p*-toluate of 4-methyl-umbelliferone, $C_{18}H_{14}O_4$, m.p. 157° , which on treatment with aluminium chloride yields a ketone, 4-methyl-8-(*p*-toluoyl)-umbelliferone, $C_{18}H_{14}O_4$, m.p. 260° . This ketone is condensed with bromacetic ester to form an ethyl ester, $C_{22}H_{20}O_6$, m.p. 130° , which on hydrolysis with alkali gives an acid, 4-methyl-8-(*p*-toluoyl)-7-(carboxymethoxy)-umbelliferone, $C_{20}H_{16}O_6$, m.p. 188° . The acid on treatment with fused sodium acetate and acetic anhydride yields 3-(*p*-toluoyl)-4'-methyl-7'-8'-furo-coumarin, $C_{19}H_{14}O_3$, m.p. 175° .

The 4-methyl-8-(*p*-toluoyl)-umbelliferone, m.p. 260° , when hydrolysed with alkali gives 2-(*p*-toluoyl)-resorcin, $C_{14}H_{12}O_3$, m.p. 125° , while the condensation of resorcin with *p*-toluic acid yields by Nencki's method, 4-(*p*-toluoyl)-resorcin, $C_{14}H_{12}O_3$, m.p. 138° .

163. A new method of the synthesis of phenanthrene and its derivatives.

N. N. CHATTERJEA, Calcutta.

A synthesis of hydroxyphenanthrene according to the following scheme is in progress.

When diphenic anhydride is reduced by means of sodium amalgam a lactide is formed, which when heated with potassium cyanide gives 2-cyanomethyl-2-carboxy-diphenyl. By the hydrolysis of this compound it is expected that the corresponding dicarboxylic acid will be obtained. The distillation of the lead salt of the dibasic acid or Dieckmann's reaction on the dibasic ester will give us the hydroxyphenanthrene.

The general importance of this new synthesis lies in the fact that the substituted phenanthrenes can be synthesised from corresponding substituted diphenic acids. It would be possible to synthesise phenanthrenes containing more than one hydroxyl group.

164. Synthesis of diphenyl derivatives. Part I.

N. N. CHATTERJEA, Calcutta.

A synthesis of unsymmetrical diphenyl derivatives having both the methyl and the hydroxyl groups attached to the nucleus is described. The process consists in decomposing the diazonium salts of benzene or toluene (*o*, *m*, *p*) in presence of cresols (*o*, *m*, *p*). Symmetrical and unsymmetrical methyl derivatives of diphenyl ether are also produced as bye-products. The products may be isolated from the reaction mixture by distillation with superheated steam.

The general method employed in determining the constitution is to protect the hydroxyl group by methylation and then oxidising with permanganate the free methyl groups to the corresponding acids. By heating with soda-lime the acids lose carbon dioxide and the methoxy diphenyl derivatives, thus obtained, are easily identified as they are all known. The acetyl derivatives of these compounds have been prepared with acetic anhydride in presence of pyridine.

Investigations on the action of various reagents, e.g. oxalyl chloride, methylene chloride, ethylene bromide, β -ketonic esters, nitric acid on these new hydroxy-diphenyl derivatives are in progress.

165. Parachor and chemical constitution. Part II. The structure of the triphenylmethane dyes.

S. K. RAY, Calcutta.

Various formulæ have been proposed by different investigators as to the structure of the triphenylmethane dyes. That there is a fundamental difference in constitution between the colourless leuco bases and

the deeply coloured dyes was recognised by many observers. The present work was undertaken to find out the constitution of the leuco bases as well as the coloured dyes. The surface tensions and densities of the leuco bases and the coloured salts of rosaniline, crystal violet and malachite green in various solvents have been determined and the parachor calculated. It was found that the colourless bases possess the benzenoid structure while the coloured salts are best represented by quinonoid configuration.

166. A synthesis of 1 : 2-diketones. The condensation of hexachloroethane with phenols.

S. K. RAY, Calcutta.

A synthesis of 1 : 2 diketones has been effected by a somewhat modified method of Reimer-Tiemann's reaction. Substituted phenols were found to react with hexachloroethane in presence of alkali yielding the corresponding diketones.

167. The condensation of chloral with thiourea and semicarbazide.

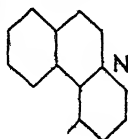
B. K. BANERJEE, Rajshahi.

The action of chloral hydrate upon urea and phenyl urea is known. Attempts have been made to condense chloral hydrate with thiourea-semicarbazide, etc. and monochloral-thiourea (m.p. 135-36°) and monochloral-semicarbazide (m.p. 212°) have been obtained.

168. Studies in isoquinoline series.

RANAJIT GHOSH, Calcutta.

Certain alkaloids, such as, emetine, cephaeline, etc. contain the

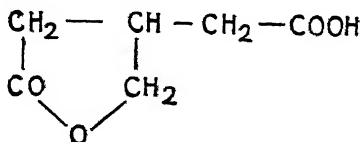


skeleton. Some interesting compounds containing this skeleton have been synthesised. Methyl-glutarolactonic acid chloride is condensed with β -phenyl ethylamine whereby the β -phenyl ethylamide derivative of the acid is obtained. The amide on treatment with phosphoryl chloride gives rise to an isoquinoline derivative. The isoquinoline base on reduction with zinc and acetic acid forms a piperidone which is now being subjected to electrolytic reduction for the synthesis of the above skeleton.

169. On the syntheses of certain γ -lactonic acids.

RANAJIT GHOSH, Calcutta.

γ -Lactonic acid of the constitution,



has been synthesised by treatment of one mol. of ethoxy acetaldehyde (obtained by the modified oxidation of ethylene-glycol monoethyl ether with sodium dichromate and sulphuric acid) with 2 mols. of malonic ester in presence of piperidine, followed by hydrolysis, decarboxylation and deethylation of the resulting compound (ethoxy-ethylidene-dimalonic ester). The reactive hydrogen atoms of ethoxyethylidene dimalonic ester may be replaced by alkyl groups by treatment with sodium ethoxide and corresponding alkyl halides, and the derivatives thus obtained on hydrolysis, decarboxylation and deethylation would give rise to a series of γ -lactonic acids. Hence this method may be considered as a general method of synthesis of lactonic acid of the above constitution. Some of these interesting derivatives have already been isolated by the author.

170. Action of amines on quinolinic acid. Part II.

A. K. DAS and INDUBHUSAN SARKER, Gauhati.

It is an extension of the work on the action of aniline on quinolinic acid. In this paper the action of benzylamine, toluidines, and aminophenols has been studied under different experimental conditions. Generally, in all these cases, at first at ordinary temperature an additive compound with one molecule of the amine is formed and then with changed condition (e.g. by heating alone or with condensing agents) it loses molecules of water forming compounds corresponding to anilides and anils.

171. Studies in xanthone group.

A. C. SIRCAR and S. C. DUTT, Calcutta.

Preparation and properties of a good number of azo compounds from diazotised 3-amino-xanthone, and azo-methins obtained by condensing various aromatic aldehydes with 3-amino-xanthone are described. Finally, two new derivatives of xanthone, namely 3-iodo-xanthone and 2-nitro-7-iodo-xanthone have been prepared from the corresponding amino compounds *via*-diazo reaction.

172. A bitter principle from *Andrographis paniculata*.

S. S. GUHA SIRCAR and ABDUL MOKTADAR, Dacca.

The crystalline bitter principle from the leaves of *andrographis paniculata* (Kalmegh), $C_{30}H_{48}O_5$ (approx.), has been obtained in a pure form, m.p. 220° . It is an unsaturated hydroxy-lactone containing a methylene-dioxy-group, and is presumably related to a sesquiterpene. Its addition products with H_2 , HCl , HBr , ICl , Br_2 , and its reactions with $POCl_3$, phenylcarbimide and various oxidising agents and also with zinc dust and soda-lime have been carefully studied. Two hydroxy acids corresponding to the lactone, and their barium salts have been obtained in crystalline condition.

173. Chemical examination of *Tylophora asthmatica*.

N. N. GHOSH, I. B. BOSE, and SUDHAMOY GHOSH,
Calcutta.

The drug is met with almost throughout India. The roots are reputed to act both as an emetic and as a cathartic. It is described as one of the best substitutes for ipecacuanha. Besides the presence of small amounts of oily matter, waxes, resins, tannins, potassium nitrate, etc., it was found to contain alkaloids. The amount of the total alkaloid obtained by assay was found to be about 0.44 per cent.

The total alkaloids isolated on a semi-large scale were found to consist of two alkaloids, both with feeble basic properties. Both were easily soluble in chloroform, but one was only sparingly soluble in absolute alcohol. The latter has been crystallised in irregular laminae with a pale yellow color, m.p. 265°. This alkaloid has been termed *tylphorine*. The base has been analysed and several of the salts, such as hydrochloride, hydrobromide, hydriodide, sulphate, nitrate, etc., prepared in a crystalline state and their properties studied. The pharmacological action is under investigation. The second alkaloid, isolated from the mother liquors of the first, could not be obtained crystalline. It was a yellow, amorphous powder, m.p. 130° and was a very feeble base.

174. Molecular size of cellulose.

J. K. CHOWDHURY, Dacca.

The molecular weight of cellulose from different sources has been determined in very dilute solution by Staudinger method. The mol. wt. of cotton, jute, and bamboo celluloses in cuprammonium sols. are thus found to be about 1,44,000, 76,000, and 26,000 respectively. The number of anhydroglucose units in each molecule being 878, 516, and 189 respectively. In viscose, the numbers are 894, 468, and 158 respectively indicating slight disintegration. In acetylcellulose, the numbers are 138 units in the case of cotton and 86 in the case of jute cellulose, indicating considerable disintegration during acetylation. The number of glucose units in natural cotton must be higher than that obtained from cuprammonium solutions and must exceed 1000.

The molecular size of the above celluloses in viscose solution has also been determined with the help of Gibbs formula from changes of surface tension with time. The molecular area by cotton cellulose is found to be 571 sq. Å, that of jute cellulose 263 sq. Å, and that of bamboo cellulose 130 sq. Å.

175. Suitability of Indian bauxite for the manufacture of alumina by Bayer's process.

G. K. OAGLE and M. S. PATEL, Bombay.

Continuing previous work most of the samples of bauxite from important Indian bauxite deposits have been subjected to Bayer's process, and the yield of alumina has been determined. Best yields have been obtained from samples of bauxite from Kolhapur State and from the recently discovered bauxite deposit by one of the authors on the Tungar Plateau near Bombay in the Thana District.

Titanium oxide and iron oxide contents of the bauxite which have been found more suitable for the extraction of alumina by Bayer's process are such that it may be possible to utilise the 'red mud' obtained after alkali digestion for the recovery of titanium salts.

Experimental data has been worked out to determine approximately the cost of production of alumina on a commercial scale.

Experiments on the recovery of titanium oxide from the 'Red mud' are in progress.

176. Study of the changes in cashewnut shell oil on heating.

N. M. PATEL and M. S. PATEL, Bombay.

Cashewnut shell oil has been extracted by solvent process from raw cashewnut shells after the removal of the kernel from the nut. The solvent used was a fraction from ordinary motor petrol distilling below 80°. It has been found that by heating the oil in the atmosphere of nitrogen up to 125°, the saponification value, acid value and specific gravity

decreases and iodine value increases with time and temperature. After heating the oil for $1\frac{1}{2}$ hours at 150° in the atmosphere of nitrogen no further change takes place in the saponification value, acid value and specific gravity of the oil.

The raw extracted oil causes blisters on human skin. The heated oil ceases to have this property. The raw oil dries more rapidly than the oil heated at higher temperature. Further work is in progress.

177. Preparation of banana or plantain flour.

M. S. PATEL, Bombay.

Drying of ripe plantains and preparation of flour from unripe plantains is being carried out as a cottage industry in the Thana and North Kanara Districts of the Bombay Presidency. Drying operations at these places are carried out by means of solar heat. The products are, therefore, not quite dry and are liable to be unhygienic as the time of exposure is about a week or more. The moisture content of the dried product reduces the keeping quality of the product considerably. Besides the product is neither crisp nor friable. The preparation of unripe plantains is also carried out under similar conditions. But as unripe banana does not contain high percentage of sugars, they dry fairly well. Fairly large amount of banana or plantain flour packed in sealed tins is being imported into this country and used as a medicinal diet. Improved and more hygienic processes for drying plantains into flakes and powder has been developed. Experiments to work out a data for designing a pilot plant are in progress.

178. Extraction of nicotine from tobacco.

M. S. PATEL, Bombay.

Black Leaf 40, a proprietary product containing nicotine sulphate as the principal ingredient, has been found by Bombay Department of Agriculture to be most effective for the control of aphids. It has also been found that nicotine in other forms also kills aphids. Black Leaf 40 is an American product and it is not available in India when required. Attempts are, therefore, being made to develop a process suitable for Indian conditions for the extraction of commercial nicotine from locally grown tobaccos. Various methods for the estimation of nicotine have been studied. Nicotine content of different varieties of tobacco grown, and commercial methods of nicotine extraction are being studied.

179. Drying of mango pulp.

M. S. PATEL, Bombay.

Continuing the previous work experiments have been carried out to work out the engineering data for the design of a pilot plant for the manufacture of mango pulp flakes or powder. The keeping quality of the mango flakes is studied. Samples prepared in the mango season of 1933 have not undergone deterioration. Further work is in progress.

180. Error in the estimation of morphine in opium by the process of British Pharmacopœia, 1932.

J. N. RAKSHIT, Gazipur.

Estimation of morphine in opium by former British Pharmacopœia process has been criticised by the author in *Analyst*, 1919, 337; 1921, 482; 1931, 711. Latest British Pharmacopœia of 1932 has introduced

some alterations over the previous methods. Attempts have now been made in the present investigation to ascertain how figures obtained by the present method represent actual morphine content on opium.

181. Determination of reducing sugars by titration of acidic potassium chromate, potassium dichromate and alkaline potassium ferricyanide solution.

S. C. SEN and M. N. PHUKON, MUSHARI.

A rapid method is described for the determination of reducing sugars by the direct titration with acidic: (1) potassium chromate solution, (2) potassium dichromate solution without using any indicator, and (3) alkaline potassium ferricyanide solution using methylene blue as an internal indicator.

The end point is observed in (1) and (2) by the sudden change of orange red colour of acidic K_2CrO_4 and $K_2Cr_2O_7$ solution to the green due to the liberation of simple Cr ion from the complex anions CrO_4^{--} and $Cr_2O_7^{--}$.

The end point in (3) is observed by the sharp change of the colour of the indicator methylene blue from deep blue to the colour of the original solution.

These methods give successful results both with grape sugar and laevulose. Attempts have been made to determine glucose in the original cane juice and agreeable comparative results have been attained with the usual Fehling's solution.

182. Influence of different reducing agents on one bath chrome liquor as regards (a) basicity, and (b) the quality of leather produced.

B. M. DAS, B. B. DHAYALE, and B. N. PAL, Calcutta.

With a view to find out how the basicity of one bath chrome liquor is affected by different organic and inorganic reducing agents used in converting bichromate acidified with sulphuric acid into basic chromic salt nine different chrome liquors were prepared by nine different reducing agents but keeping the amounts of bichromate and sulphuric acid the same in all of them. It was found that the basicities differed widely with different reducing agents.

Practical tanning tests were made with the nine different liquors and the characteristics of the final leather studied. It was found that the reducing agents materially affected the properties of the leather.

183. The estimation of small quantities of bromine by a new colorimetric method.

A. C. BOSE and K. N. BAGCHI, Patna.

A perusal of the literature does not show any work done on colorimetric estimation of bromine. The difficulty lies in the fact that bromine escapes from the standard solution and renders the matching useless. This has been overcome by using an aqueous solution of methyl orange as a stable substitute for bromine solution.

The method described in this paper consists in oxidizing a soluble bromide in acid solution with $\frac{N}{50}$ $KMnO_4$ and dissolving out the liberated bromine with carbon tetrachloride and then matching it in a colorimeter against the standard methyl orange solution. The methyl orange solution is standardised by matching it against bromine from KBr solution of known concentration. The colorimetric reading (the standard being set at

20 mm.) thus obtained has been termed in this paper as *Colorimeter Factor* which will be the basis of all calculation for estimation of bromine in an unknown solution.

Calculation of result.—The colorimeter reading of the unknown solution with reference to the standard methyl orange set at 20 mm., is taken as the numerator and the colorimeter factor nearest to the observed reading (given in detail in the tables appended to the paper) and corresponding to the same strength of methyl orange is taken as the denominator. This is multiplied by the concentration of bromine in the known KBr solution (originally used for standardising the methyl orange solution) corresponding to the same colorimeter factor. Hence, the percentage of bromine in the unknown solution

$$= \frac{\text{Reading of the unknown}}{\text{Colorimeter Factor}} \times \text{Concentration of Br.(\%) in the bromide solution corresponding to the colorimeter factor.}$$

In all colorimetric estimations with a colorimeter of Duboscq type the standard is generally set at 20 mm. and is always taken as the numerator while the observed reading of the unknown as the denominator but in this method the usual arrangement has been reversed the explanation of which and also the deduction of the formula given above, have been described in the paper.

Apart from its intrinsic worth for estimation of small quantities of bromine colorimetrically, the importance of this method lies in the fact that an entirely different substance like methyl orange which has nothing in common with the substance to be estimated, can be utilised as a standard for colorimetric comparison and the usual method of calculation can be completely modified according to changed conditions. This method is, therefore, likely to throw more light in colorimetric field where the worker is often handicapped for want of a suitable standard.

184. Study of the exchange absorption in soil by velocity reaction.

S. C. SEN, Mushari.

The energy absorption of cations by the colloidal complex varies considerably. The absorption of the principal ions Ca^{++} , Na^+ , by artificially prepared soils containing $\text{H} \cdot \text{Ca}^{++}$ and Na^+ as the exchangeable cations has been studied.

The process of replacement of an absorbed ion by another in soil is expressed by the monomolecular velocity reaction.

$$K = \frac{2.303}{t_y - t_x} \log \frac{(c)_x - (c)_x}{(c)_y - (c)_y}$$

where $(c)_x$, $(c)_y$, and $(c)_\alpha$ are respectively the content of the replaceable ion per gram absorbed in the system after the interval of x , y , and α length of time. The duration of the complete reaction is short.

Both Na^+ and Ca^{++} soils prepared from the artificial hydrogen soil and then replacement of Ca^{++} by Na^+ and Na^+ by Ca^{++} have been verified by the above reaction. The order of absorption from the velocity constant is in the order of $\text{Ca}^{++} > \text{Na}^+$.

The exchangeable capacities of other artificial soils are in progress.

185. On the variation of the oxidisability and acid values of Indian butter fat and their bearing on rancidity.

B. M. GUPTA and S. C. ROY, Lucknow.

Attempts have been made to find out the variation in the oxidisability and acid values of butter fat prepared under different conditions

and the factors which influence these values. Efforts have also been made to find out to what extent these values can indicate the degree of rancidity.

186. On the relationship between the saponification value and the proportion of insoluble fatty acids of butter fat.

B. M. GUPTA and J. M. DHAR, Lucknow.

The ordinary tests for the determination of purity of butter fat usually depend on an estimation of the soluble and insoluble parts of volatile fatty acids. It appears that an examination of the insoluble acids can be utilised as an additional test for purity. It has been found that there is a relationship between the saponification value and the percentage of the fatty acids giving insoluble salts, and that for a definite value of the former there is a maximum value of the latter for all specimens of pure butter fat.

187. On the analytical constants of oils derived from certain varieties of mustard seeds grown in the United Provinces.

B. M. GUPTA and M. G. CHAKRAVERTY, Lucknow.

Although the investigations of Prain, Kinzel, Duthie, and Fuller have thrown a considerable amount of light on the characteristics of the different varieties of mustard seeds which are cultivated in India, there are still serious ambiguities so far as the vernacular names are concerned, and the 'Tori' of one district, may be the 'Lahi' of another, or the 'Sarson' of a third. Great difficulties are, therefore, experienced in collecting authenticated seeds. As mustard oil is an important article of food, a careful examination of the analytical constants of the oil derived from each variety separately is of great importance.

In the present investigation authenticated seeds of *Brassica campestris* Linn., *Brassica rugosa* Prain, *Brassica napus* Linn., and *Brassica Juncea* were obtained from the Divisional Superintendents of Agriculture and the specimens of oils derived were examined in accordance with the standard methods. Further examination will be made as soon as genuine seeds of other varieties can be procured.

188. Constitution of iodic acid and its salts. Part III.

M. R. NAYAR and L. N. SRIVASTAVA, Lucknow.

In the two previous papers (*Proc. Ind. Sc. Congress*, 1933, p. 199; *ibid.*, 1934) it has been shown from a number of considerations and experiments on freezing point, conductivity and Raman effect that iodic acid in concentrated solutions is polymerized while in dilute solutions it has the simple formula of the monobasic acid HIO_3 and iodates are derivatives of this last acid.

A further confirmation of the change in constitution of the acid with dilution is obtained from measurements of viscosity of iodic acid solutions from concentrations ranging from $5N$ down to $N/100$. The graph obtained by plotting the logarithm of the molecular viscosity against the logarithm of concentration is nearly a straight line which changes its direction at about $1N$.

189. Utilisation of waste vegetation. Part I. Gasification of prickly pear (*Opuntia Dillinii*).

B. S. SRIKANTAN and S. RENGACHARI, Madras.

The sun-dried plant containing 16% of moisture and having a calorific value of 497 B.T.U. has been gasified by the Mond process to

yield gases of high calorific value, ranging from 150 B.T.U. per cu. ft. to 425 B.T.U. per cu. ft. depending on the ratio of steam to air and the space velocity. About 60% of the nitrogen content in the plant is obtained as ammonium sulphate. The ash of the plant yields 25% of alkali chiefly K_2CO_3 which is to be considered an important source.

190. A note on an examination of a mineral water in the Tinnevely District.

K. VENKATAKRISHNAYYA and S. RANGACHARI, Madras.

The geological characteristics of the locality is described. The spring water contains plenty of pure hydrogen sulphide and colloidal sulphur. The results of an examination for the mineral contents of the water are given.

191. Thermionic emission and catalytic activity. Part III. A mechanism of the activation of gases at hot metallic surfaces.

B. S. SRIKANTAN, Madras.

In part I (*Ind. Jour. Phys.*, 1931, V, VII, 685) the author has shown that catalytic activity of metals depends on their capacity to emit electrons at the temperatures at which chemical reactions are catalysed. In part II (unpublished) it is noted that a thorium ceria surface having 1% of ceria shows maximum thermionic emission than other mixtures. Swan (*J. Chem. Soc.*, 1924, 125, 780) finds that catalytic activity of this mixture is also maximum at this particular concentration. In this paper the two sets of observations are correlated and a mechanism of activation of gases at metallic surfaces is given on the assumption that adsorbed gases are activated in collision with freely moving electrons in the metal and that the velocity constant at any temperature is proportional to the saturation current at that temperature. An expression is derived connecting the velocity constant and temperature

$$K = Y T^{3/2} e^{-(b/T+X)},$$

where K =velocity constant, T =temperature, Yb and X are constants.

This equation has been tested for the decomposition of ammonia on tungsten and of nitrous oxide on platinum. Under simplifying conditions this equation reduces to that of the well-known but empirical equation of Arrhenius.

192. Sweet water fish oil. Part II. Liver oil of *Dhai fish*.

D. N. MAJUMDAR, Calcutta.

The preliminary examination of the oil has been done and the work on the separation of the constituent of the fatty acids is in progress.

193. Some inorganic preparations of the indigenous medicine. Part II. *Banga Bhasma* (Calcined tin).

R. N. CHOPRA, SUDHAMOY GHOSH, and A. T. DUTT,
Calcutta.

This substance is believed to be a general tonic and alterative. It is used in the Hindu Medicine in diabetes, spermatorrhœa, gonorrhœa, anæmia, asthma, gastric ulcer and various skin diseases, the dose being 1 to 4 grains. The material usually obtained is a dully grey amorphous

powder with a slightly saline and metallic taste. A complete qualitative and quantitative analysis showed the presence of about 83% of oxide of tin together with silica, iron, alumina, lime, magnesia, potash, soda, chlorides, moistures and traces of other constituents. The amount of mineral matter soluble in the concentration of hydrochloric acid occurring in gastric juice was also determined and the constituents estimated. Clinical trials with the drug were carried out.

194. Some inorganic preparations of the indigenous medicine.
Part III. *Lauha Bhasma* (Calcined iron).

R. N. CHOPRA, SUDHAMOY GHOSH, and A. T. DUTTA,
Calcutta.

This substance is used in the Hindu Medicine in all forms of anæmia, general debility, tuberculosis, skin diseases and gastric and duodenal ulcer, the dose being 2 to 10 grains. The material obtained was an amorphous powder with a chocolate colour. It was subjected to a complete qualitative and quantitative analysis and found to contain about 91% of oxide of iron together with silica, lime, magnesia, phosphate, chloride, sulphate, and traces of potash and soda. The amount of mineral matter soluble in the concentration of hydrochloric acid occurring in gastric juice was also determined and the constituents estimated. The results of some clinical trials with the drug and their relationship with the constituents found are discussed.

195. An improved method for measuring optical rotatory dispersion.

R. PADMANABHAN, Bangalore.

The usual photographic method does not give accurate results with substances of low rotation and fails entirely for substances of little or no rotatory dispersion. The method described consists in combining such a substance with another of appreciable rotation and high dispersive power, when it becomes possible to determine the R.D. of the combination by the usual method. The R.D. of the latter is separately determined and by difference the R.D. of the substance of low rotation or low dispersive power can be found out. The usefulness of this method in working with dilute solutions in the vicinity of an absorption band is indicated and its applicability for substances of low dispersive power such as sodium tartrate and nopinene is illustrated in the latter case with readings and photographs.

196. Analytical uses of potassium mercuric iodide.

K. RAY, H. N. DAS-GUPTA, and M. N. GOSWAMI, Calcutta.

In alkaline solution (NaOH) it helps us to distinguish aldehydes from ketones. The former gives black metallic mercury whilst the ketones are unaffected. The earlier statement of Gros (*Pharm. Chim.*, 1922, 26, 5) who examined few ketones and found that they also reduce, has been found to be inaccurate. Monohydroxy aldehydes like salicylic aldehyde, vanillin do not react, perhaps due to mercuration. Methylation restores the action as veratric aldehyde easily reduces. Potassium mercuric iodide solution made alkaline with sodium carbonate has been used by the authors for the quantitative estimation of glucose. The method is very simple. To about 35 c.c. of the reagent 50 c.c. of 10% Na_2CO_3 solution and then the sugar solution are added and the mixture boiled for 5 minutes when the corresponding amount of Hg is formed. The solution is cooled and neutralised with acetic acid and iodine solution added. The excess of iodine remaining is titrated. $\cdot 0045 \text{ G. of glucose} = 1 \text{ c.c. } \frac{N}{10} \text{ Iodine.}$

197. On the catalytic activation of diastase.

SOBHANLAL BANNERJEE and H. K. SEN, Calcutta.

Following a work on synthetic enzymes, specially the action of phenyl amino acetic acid on pyruvic acid to simulate the enzyme carboxylase (*Proc. Institution of Chemists. India*), it was considered necessary to investigate if the carboxylase itself is activated by the addition of phenyl amino acetic acid or similar substances. With phenyl amino acetic acid, the activation of the carboxylase reaction of yeast is definite and a further activation was attempted by the catalytic action of the ultraviolet light. The result was not only not activating, but positively destructive. This was only to be expected, as the diastatic ferment in malt was known to be rendered completely inactive by the action of the ultraviolet light (Pincussen, *Biochem. Z.* 134, 459, 1923; 144, 366, 1924; 152, 406, 416, 1924). The significance of such a destructive property of the ultraviolet light in therapy is obvious, but the discovery of protective reagents would be no less important, as the latter would increase the flexibility of the employment of such light in the science of actinotherapy. Accordingly, four sets of experiments were performed with malt diastase: (i) without catalyst, (ii) with catalyst, (iii) with catalyst and ultraviolet light and finally (iv) with ultraviolet light but without catalyst.

As a result of numerous experiments, it appears that asparagine, phenyl amino acetic acid, gelatine, tyrosine, amonobenzoic acid, ammonium citrate, exert varying degrees of protective action on malt diastase. Thus, exposure of 5 minutes to ultraviolet light (3,000 C.P.) and 12" arc at a distance of 2 feet, was just sufficient to completely destroy the diastatic activity of a sample of malt. If gelatine were added during the reaction, and the reaction tube exposed to the action of ultraviolet light exactly similarly for 5 minutes only, the diastatic power though reduced, was still found to be 15.16, as against 23.5 without the light. When exposed for 45 minutes, the diastatic value fell to 9.6. On the other hand, for the same period of 5 minutes, ammonium citrate of identical concentration and conditions of exposure gave the diastatic value 11. This shows that the protective action of gelatine is more than that of ammonium citrate. If gelatine be taken as a standard for comparison, a system of expressing the protective co-efficient may be introduced. But it is quite possible that certain substances function both as protectors and accelerators. For example, phenyl amino acetic acid, tyrosine, aminobenzoic acid, ammonium citrate are both accelerators and protectors. Whilst from the chemical nature of the accelerators, a surmise may be made as to the probable nature of the diastatic fraction of malt, the protective action probably depends upon the capacity to absorb partially or wholly the destructive wavelengths of the ultraviolet light. Expressed in a slightly different way, the light acts selectively on these protectors, leaving the diastatic enzyme wholly or partially active. This appears to be plausible when we consider that gelatine, ammonium citrate and in fact many albuminoid substances are affected by the ultraviolet light. Further investigations are in progress.

198. The neutral oil and the phenol ratio in the low-temperature carbonisation tar of Indian coals.

S. S. GHOSH, H. K. SEN, and PROBHAT BANNERJEE,
Calcutta.

The ratio of neutral oils to the phenols in coal-tar is important from the point of view of its use in internal combustion engines. Addition of heavy boiling neutral oils to petrol appreciably increases the efficiency of internal combustion engines by the higher ratio of compression that can be used. The practically complete elimination of phenols by a single

fractionation without the use of alkalies to neutralise the latter, would constitute a great improvement both by reducing the cost of fuel as also by creating a definite market for the low-temperature tar. On distilling some of the second class coals from Indian collieries, the neutral oil and phenolic oil ratio was usually found to be between 2 and 31/2. Distilling the coals, however, with a mixture of sodium carbonate, sodium acetate and iron filings, this ratio becomes as high as 5 to 7, meaning thereby that the proportion of phenolic bodies is very considerably diminished, rendering the once distilled tar fit for being used directly in internal combustion engines. Engine trials with a 25% mixture of the distilled tar with petrol are in progress.

199. A semi-technical apparatus for the saccharification of saw dust by pressure percolation.

B. D. GUPTA and H. K. SEN, Calcutta.

The importance of pressure percolation in the saccharification of cellulosic materials has been brought into prominence by the work of Schooler who claims a 90% conversion of cellulose into sugar by such an operation. The need for the verification of this and similar other statements being felt on a semi-technical scale, an apparatus was designed which was simple in its construction, and obviated the use of a boiler or spiral heater by the use of a set of ring burner. The pressure of steam inside the percolator was maintained uniformly at 10 to 12 atmospheres, whilst a 0.123% solution of sugar was continually tapped by percolating with a 0.5% sulphuric acid solution.

200. Recovery of sulphuric acid by bauxite in the saccharification of wood.

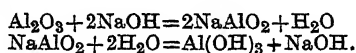
S. S. GHOSH and H. K. SEN, Calcutta.

With 72% sulphuric acid, as is well-known, the saccharification of saw dust or indeed of any cellulosic material is complete, but the chief drawback of such a process for technically obtaining sugar solutions for fermenting into power spirit, lies in the removal and recovering of the very large quantity of sulphuric acid used in the process. The acid can be neutralised almost wholly by the addition of very finely powdered bauxite, supplemented by a small quantity of precipitated alumina, and the liquor concentrated under reduced pressure. When the concentration is such that the liquor shows signs of crystallisation, a quantity of alcohol is added to precipitate out all the aluminium sulphate retained in the sugar solution. After collecting the practically pure aluminium sulphate by suction or centrifuging and washing the precipitate with a little fresh alcohol, the combined filtrate is either used for the precipitation of aluminium sulphate in subsequent experiments, or is directly distilled to remove as much of the alcohol as possible. The residual liquor has now not infrequently a strength of 4 to 5% in its sugar content, which is then fermented by acclimatised yeast. The aluminium sulphate obtained in the process could be disposed of directly, or it could be roasted at about 850° C. when practically pure alumina remained behind, whilst the sulphur was quantitatively reproduced as sulphur trioxide, sulphur dioxide, and oxygen which could be used by converting the gas mixture into sulphuric acid by passing through a contact plant. The alumina obtained in the process could be utilised for the production of metallic aluminium, aluminous cement, or when a cyclic operation is intended, the same could be fused with sodium carbonate or sodium sulphate and carbon and re-obtained as precipitated alumina, to be used in the neutralisation of the sulphuric acid in preference to bauxite. In a cyclic operation, therefore,

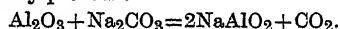
sodium carbonate would be a by-product, a feature of the process which deserves very serious consideration on account of the fact that there is no alkali industry in the country.

The following chemical reactions indicate the gist of the processes of recovery :—

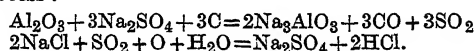
Bayer process :



Devilé-Pechiney process :—



Peniakoff process :—



201. Studies in the lignocellulose group. Part VI.

[BASUDEB BANNERJEE and H. K. SEN, Calcutta.

A significant fact has been observed in course of investigation in this line that chlorine peroxide solution does not remove all the lignin from saw dust, but about 6% of lignin still adheres to the cellulose isolated by the chlorine peroxide method. An oxymethyl determination of a specimen of cellulose so prepared, and that after removal of the cellulose by Willstätter process, showed definite presence of lignin, the percentage of OCH_3 in the adhering lignin being about 8%. That this oxymethyl is not a characteristic of β -cellulose as maintained by Cross and Bevan (*Cellulose*, 1916, p. 93) is proved by the fact that all the cellulose isolated by the chlorine peroxide method does not go into solution on being treated with HCl (sp. gr. 1.2). There is reason to believe that a part of the methoxy in saw dust exists as methyl ester.

202. Synthesis of α -substituted cinchoninic acids through the Knoevenagel catalysts.

K. M. PANDALAI, Waltair.

The 3-substituted phenacylidene oxindoles (I) obtained by the condensation of isatin and methyl ketones in presence of the Knoevenagel catalysts like diethylamine, piperidine, aniline and ammonia and subsequent dehydration in presence of dilute mineral acid cannot be converted into the 2-substituted cinchoninic acids (II) under the conditions of the Pfitzinger reaction (33% KOH and heat to 10 hours). This is evidently because these unsaturated oxindoles (I) have the *trans* configuration and are compounds formed without the hydrolytic opening of the oxindole ring. These (I) could, however, be made to yield the α -substituted cinchoninic acids (II) if geometrical inversion is effected of the *trans* isomer by the ultra-violet light method of Stoermer when the *cis* modification is formed and gives with dilute mineral acid the desired cinchophens (II). The Pfitzinger reaction, therefore, takes place presumably in three stages: (1) hydrolysis of isatin into *o*-amino benzoyl formic acid; (2) the reaction between the ketone carbonyl of the methyl ketone and the amino group of the *o*-amino benzoyl formic acid; and (3) elimination of a molecule of water from the carbonyl of the benzoyl formic acid and methyl in the methyl ketone effecting a ring closure giving the compounds of type (II). Thus it is evident that the 3-disubstituted oxindoles and the 3-substituted unsaturated oxindoles (I) are not intermediates in the Pfitzinger synthesis of substituted cinchoninic acids. The use of

the Knoevenagel catalysts for condensation of isatin and methyl ketones and subsequent geometrical inversion of the *trans*-compound into the *cis*-compound followed by dehydration of the last with dilute mineral acid afford an excellent method for the synthesis of alkali sensitive quinoline derivatives from isatin avoiding strenuous alkali treatment.

203. Adsorption and H-ion concentration. Part II.

N. A. YAJNIK, D. N. GOYLE, and J. R. JAIN, Lahore.

The adsorption of chrysoidine, acridine orange, water-blue and indigo-carmin from solutions of different pH by silica, alumina, and animal charcoal has been studied. It was found that the adsorption increases with the decrease of pH in the case of the acid dyes while reverse is the case with the basic dyes.

204. Studies in sorption of gases by solids.

N. A. YAJNIK, D. N. GOYLE, and B. N. SIKKA, Lahore.

The sorption of hydrogen, oxygen, nitrogen, carbon dioxide and carbon monoxide by a number of metallic oxides, carbonates and sulphates and by some metallic nitrates, phosphates and sulphites has been studied. It was noticed that the solvent having a high sorptive power for one gas has generally a comparatively high sorptive power for the other gases as well and that on comparing the sorptive powers of the compounds of the elements belonging to the same group of the periodic classification it was noticed that the substances having lower molecular weights and lower molecular radii have higher sorptive powers.

205. Use of brucine in volumetric analysis.

D. S. N. MURTY and T. R. SESHADRI, Waltair.

Brucine sulphate has been employed as internal indicator in estimations of (1) iron in its salts and ores and (2) organic matter in the soil when titrations with dichromate have to be carried out. The difficulties met with in the use of diphenylamine are avoided by this means and the end points determined more accurately.

206. Relation between the sulphur content and the decomposition-points of Indian coals.

R. K. DUTTA ROY, Jamshedpur.

Very little efforts have so far been made to study the mechanism of caking process of Indian coals. Factors such as decomposition points, softening points, swelling curves, plasticity zone, etc. contribute a great deal to a comprehensive understanding on the salient features of the formation of cokes. The decomposition point is just the critical limit when a coal in the destructive distillation just begins to give forth tar. The present study consists of a fairly elaborate investigation on the sulphur content and the decomposition point of Indian coals. The striking result is that there exists some definite relation between the percentage of sulphur and the decomposition point. Moreover, the sulphur content of coal is also a function of its geological age.

207. A relative study on the ultimate analysis of coal.

R. K. DUTTA ROY, Jamshedpur.

As it is evident, the ultimate analysis of coal plays an important rôle in the industrial valuation. It will considerably economise time and do away with the usual tedious laboratory methods if a workable and

speedy relation be established with comparatively easier proximate analysis and the calorific value of coal. Efforts have already been made to establish such relation regarding the continental and American bituminous coal. The present study comprises a practicability of such possibilities regarding the Indian bituminous coal.

208. Formation and transformation of carbon ring compounds. Part III.

S. C. SENGUPTA, Calcutta.

The anhydride of *cyclohexane-1-carboxy-1-acetic acid* condensed with benzene in presence of aluminium chloride giving *cyclohexane-1-benzoyl-1-acetic acid* (m.p. 117-118°), this on reduction by the Clemmensen's method gave *cyclohexane-1-benzyl-1-acetic acid* (m.p. 93°). On cyclisation with 85% sulphuric acid this acid furnishes 1-keto-1:2:3:4-tetrahydronaphthalene-3:3-spirocyclohexane (b.p. 145°/3 mm.); this on again reduction by the Clemmensen's method gave 1:2:3:4-tetrahydronaphthalene-3:3-spirocyclohexane (b.p. 115-117°/3 mm.). This spirohydrocarbon on selenium dehydrogenation at 300-350° gave phenanthrene and no methylphenanthrene or anthracene could be detected.

209. Percarbonates.

R. RAO KAMTIKAR and SYED HUSAIN, Hyderabad.

Nature of percarbonates was investigated. Wolfenstein and Peltner's percarbonates, namely, $\text{Na}_2\text{C}_2\text{O}_8$ and $\text{Na}_2\text{CO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ were found to be mixtures of sodium carbonate and sodium bicarbonate; and $\text{Na}_2\text{C}_2\text{O}_8 \cdot \text{H}_2\text{O}_2$ was found to be $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3 + \text{H}_2\text{O}_2 \cdot \text{XC}_2\text{H}_5\text{OH}$. The existence of Tanatar's compound $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}_2 \cdot \frac{1}{2} \text{H}_2\text{O}$ was confirmed.

210. Chromium-plating from a Dichromate-bath. Part I.

S. R. PATHAK and S. HUSAIN, Hyderabad-Dn.

Cr-plating has been largely developed very recently for surface coating of plates and other articles. Divalent and trivalent Cr. salt solns. do not give a satisfactory deposit of pure Cr. Best results are obtained from chromic acid bath containing a little chromic sulphate. Almost all the patents specify the use of chromic acid soln. as an electrolyte. The authors have investigated the electrolysis of $\text{K}_2\text{Cr}_2\text{O}_7$ soln. in presence of various acids. They started with sulphuric acid. The results obtained were very satisfactory. A soln. containing 0.5 M. $\text{K}_2\text{Cr}_2\text{O}_7$ + 0.12 M. H_2SO_4 on electrosynthesis with a c.d. of 0.4 amp./cm.² gave a bright white and tenacious deposit of Cr. at 30° C. The c.c. was about 35 %. Further investigation is in progress.

211. Formation and Stability of the Complex Ammines.

BINAYENDRA NATH SEN, Calcutta.

An attempt has been made to extend the author's view of the reactivity of elements (Sen, *Nature*, 129, 585, 1932; *Chemical News*, 145, 93, 1932; *Zeit. Anorg. Chem.* 212, 410, 1933; *Current Science*, 2, 11, 434, 1934) to explain the formation of complex ammines. The capability of the formation of the complex ammines has been shown to depend on the closest atomic approach values of the central element. The stability of the ammines has been shown to be a function of the ionisation potential and the closest atomic approach of the central element.

212. On the calculation of Entropies of Metallic Elements.

BINAYENDRA NATH SEN, Calcutta.

An attempt has been made to calculate the entropies of metallic elements by taking account of their atomic constraints and by applying the author's mode of evaluation of such constraints (Sen, *Journ. Ind. Chem. Soc.*, April issue, 1934). The formula may be indicated thus:

$$S_T = \frac{3}{2} R \ln \left\{ \left(\frac{M}{K} \right) \times \frac{V_s^3}{(P - V) Z_e^2} \right\} + 3 R \ln T + \frac{3}{2} \left(G^2 \frac{T}{T_s} A_0 \right) + C$$

where P is the parachor; T_s the melting temperature A_0 , K, C_2 constants, all other symbols having their usual significance.

The values calculated with the help of the above formula appears to be comparable with those accepted.

213. Adsorption on Asbestos. Part I.

BINAYENDRA NATH SEN, Calcutta.

Adsorption of iodine by asbestos from the different alcoholic solutions has been studied. The adsorption isotherm has been found to be approximately followed.

Section of Geology.

President :—DR. M. S. KRISHNAN, M.A., Ph.D., A.R.C.S., D.I.C.

Presidential Address.

THE DHARWARS OF CHOTA NAGPUR—THEIR BEARING ON SOME PROBLEMS OF CORRELATION AND SEDIMENTATION.

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I. INTRODUCTION.

During the twenty-one years of the existence of the Indian Science Congress, this section has been addressed by many eminent geologists on a variety of subjects covering every branch of geology, including even the broader aspects such as geological education and industrial mineral research. A wide field is available to one who is privileged to address you from the Presidential chair. I thank you for the honour you have done me, and shall take this opportunity to place before you some aspects of the problems encountered in the study of the Dharwarian rocks of India, in particular those of Chota Nagpur.

In spite of the large amount of painstaking work devoted to these ancient rocks, the present state of our knowledge shows that there are still large gaps to be filled up by further intensive and systematic study before anything like universally applicable and acceptable generalizations can be made about them. But periodic review and statement of the position of our knowledge are useful as a means of classifying and systematizing the accumulated data. So long as these generalizations are recognized as temporary working hypotheses and do not lead to oversimplification of essentially complex problems, such attempts are not only useful but form necessary stages in the advancement of the science.

The complexity in the study of these formations arises

from various factors. There is a complete absence of fossils, whose presence in the later systems is of great help in correlation and in the study of physiography, conditions of sedimentation, etc. There is a great variation in the types of rocks met with—both igneous and sedimentary. But their original characters are almost always indeterminable because of metamorphism. The effects of various grades and types of metamorphism coupled with a good deal of transfer of material have to be taken into account, and these are so complex in character and capable of producing similar types of rocks from those originally distinctive or *vice versa*. There are the effects of earth movements and regional compression which, it is well known, have produced extremely complex structures in these ancient rocks. Lastly, repeated igneous action with its attendant contact effects, assimilation and hybridism introduces further complications. No wonder therefore that every study or restudy of these ancient rocks in the light of the advancement of the science brings out new factors which may change or modify previously held ideas.

There has been a certain amount of confusion in the definition of the term Archæan. That adopted by Sir T. H. Holland¹ and generally accepted, includes all the rocks below the Eparchæan unconformity, which, in India, lies below the base of the Cuddapahs and their equivalent formations. An important part of this is classed as the Dharwar system (called in the olden days the Sub-metamorphic series or the Lower Transition rocks) consisting to a large extent of sediments with much igneous rock inseparably intermingled with them. The gneisses, granites and other igneous rocks of an age older than the Eparchæan interval may be classed under the general term 'Archæan', i.e. under that part which does not include the Dharwars. Such a definition is admittedly rather vague, but it is about the best that one can venture at present.

Not very long ago, the Dharwars were regarded as younger than the associated gneisses and granitic rocks, which were, in part at least, thought to represent the primordial crust of the terrestrial globe. But all observations during the last twenty-five or thirty years have tended to support the opinion that there are few, if any, rocks which can be regarded as older than the Dharwars with certainty. This opinion is held by the Mysore geologists, and has been voiced by Dr. Fermor² in his Presidential address to this section in 1919. The original crust is considered to have been repeatedly fused and assimilated by successive intrusions so that very probably none of it remains at present. The gneissic complex found in Mysore and South

¹ *Trans. Min. Geol. Inst. Ind.*, I, p. 47, (1907) : *Mem. Geol. Surv. Ind.*, XLIII, Pt. 1, p. 18, (1913).

² *Jour. Asiatic Soc. Bengal*, N.S., XV, clxxv-clxxvi, (1919).

India, now called the Peninsular gneiss group, was formerly considered older than the Dharwars. But all recent observations go to show that this group, comprising injection-gneisses, granites and associated pegmatites, aplites, etc., exhibits distinct intrusive relationship towards the Dharwar schists wherever it has been found, under favourable conditions for observation, in juxtaposition with the latter. This is the case, at any rate, in South India, Bihar and Orissa, and the Central Provinces. But in Rajputana, Dr. Heron has found evidence to regard the gneissic complex and the Bundelkhand gneiss as distinctly older than the Aravalli system which is generally admitted to be the equivalent of the Dharwarian rocks of other parts of the Peninsula.

II. THE DHARWARS OF CHOTA NAGPUR.

Before proceeding to discuss some of the problems connected with the Dharwars, I shall give a summary idea of the geology of Chota Nagpur, a region in which I have worked during the past nine years and which I can use as a basis for discussion.

The history of the geological investigation of the Chota Nagpur tract dates practically from the work of Dr. V. Ball,¹ published in 1881. Much of the area was assigned between the two formations—the Metamorphic series and the Sub-metamorphic or Transition series, the latter being now called the Dharwars. Immediately after the gold boom of the close of the last century, Messrs. J. M. Maclaren and F. H. Smith continued the work westwards, mainly investigating the possibilities for gold in this area. Maclaren² definitely identified the Transitions in this area with the Dharwars of South India and also found a belt containing limestones, dolomites and phyllites, which he described as the equivalents of the Cuddapahs. This work, however, did not extend far enough west to the border of Sambalpur, where Ball³ had come across the same limestones near Kujirma (Kujerma in Ball's paper) and had assigned them to the Dharwars. The only other published work of importance on this area, before the recent survey was commenced, is a paper by Dr. L. L. Fermor⁴ on the manganese-ore deposits of Gangpur State wherein he recognized the limestones, dolomites and phyllites, which occur with the manganese-bearing rocks, as belonging to the Dharwar age.

The Bihar and Orissa Party of the Geological Survey of India have been engaged in remapping Singhbhum, Gangpur,

¹ V. Ball : Geology of the districts of Manbhum and Singhbhum. *Mem. Geol. Surv. Ind.*, XVIII, Pt. 2, (1881)—reprint, 1934.

² J. M. Maclaren : The Auriferous occurrences of Chota Nagpur, Bengal. *Rec. Geol. Surv. Ind.*, XXXI, p. 70, (1904).

³ V. Ball : On the geology of the Mahanadi basin and its vicinity. *Rec. Geol. Surv. Ind.*, X, p. 182, (1877).

⁴ *Rec. Geol. Surv. Ind.*, XLI, pp. 12-21, (1911).

and the adjacent parts for over a decade past, my work having been mainly in the Gangpur State.

The greater part of the eastern half of this State is structurally a geo-anticline or anticlinorium with a general E.N.E.-W.S.W. axial direction, the structure being a closed one towards the east on the Singhbhum border. Towards the west there are subsidiary folds in which the rocks are greatly compressed, and further on the series becomes attenuated and obscured by granitic intrusives. Beyond and west of longitude 84° , the general strike swerves round to the W.N.W.-E.S.E. direction, and the series is to be seen in Western Gangpur, though in a less complete and less easily recognizable form.

The succession in the Gangpur anticlinorium and its vicinity is shown below :—

Dharwar system.	Iron-ore series.	Phyllites and shales. Crush conglomerate (Raghunathpali)—shear or thrust zone.
	Gangpur series.	Phyllites and mica-schists. Upper carbonaceous phyllites. Calcitic marbles. Dolomitic marbles. Mica-schists and phyllites. Lower carbonaceous phyllite and banded quartzite, mica-schists, and phyllites. Manganiferous (Gonditic) rocks with associated mica-schists.

The rocks of the Gangpur anticlinorium, whose thickness is not less than 10,000 ft., form a distinct entity for which I have proposed the name *Gangpur series*.¹ The lowest beds of the series, which form the core of the structure, are marked by the presence of manganiferous rocks of the gondite type which are found in several places between Gobira ($22^\circ 19' : 84^\circ 41'$) on the east and Ghoriajor ($22^\circ 2' : 84^\circ 8'$) on the west. Whereas in the eastern outcrops only quartz and spessartite are found, the western ones show also other manganese silicates like rhodonite, blanfordite and winchite, suggesting more stringent metamorphic conditions. A thickness of mica-schists intervenes between them and the lower carbonaceous phyllites. These latter are essentially soft black phyllites in which fine carbonaceous matter is more or less evenly distributed, the carbon content ranging up to 15 per cent. Part of this stage is composed of finely banded, grey to black, cherty quartzites, which bear an extraordinary resemblance to the banded hæmatite-jaspers in their texture and structure. These have, in places, been extensively silicified. The upper carbonaceous phyllite stage bears a general resemblance to the lower one, except for the fact that the quartzites are not abundant in the former. Between the two carbonaceous stages is a thickness, averaging

¹ General Report for 1932. *Rec. Geol. Surv. Ind.*, LXVII, p. 64, (1933).

2,100 ft., of dolomitic and calcitic marbles. The dolomites, which constitute nearly two-thirds of the thickness of the marbles, form the lower beds and pass upwards into the limestones. In places they (particularly the magnesian zones) have been converted into rocks containing diopside, tremolite, epidote and phlogopite, but as far as I am aware, no garnet or wollastonite. The well-bedded appearance and regularity of these marble beds led Maclaren to regard them as of Cuddapah age, but there is no doubt that they belong to the same series of metamorphosed rocks of which the goudites are an important member.

At the top of this series,—which may be regarded as the bottom beds of the overlying Iron-ore series—lie the Raghunath-pali conglomerates which are sedimentary in origin¹ though to a certain extent autoclastic characters have been superimposed on them. They contain pebbles of quartzite, micaceous quartz-schist, phyllite, tourmaline-quartz rock and rarely granite. They form an exceedingly well-defined zone extending right along the southern and eastern border of the Gangpur anticlinorium from Amasranga ($22^{\circ} 1' : 84^{\circ} 11'$) to Sirka ($22^{\circ} 23' : 85^{\circ} 7'$). On the north they are represented by gritty quartzites, which are however not very conspicuous. The conglomerates undoubtedly mark a shear zone but it is not clear whether this is accompanied by any overthrusting.

The portion of the Iron-ore series lying over the Raghunath-pali conglomerate consists of phyllites grading into shales towards Singhbhum and into mica-schists towards the west. In Singhbhum the succession of strata has been established as follows² :—

	Cuddapah or earlier.		Newer Dolerite.
			Granite and granite-gneiss.
			Ultrabasic igneous rocks.
			Upper shales with epidiorite and contemporaneous lavas and ash-beds near the top.
Upper Dharwars.		Iron-ore series.	Banded hæmatite-quartzite with Iron-ore.
			Lower shales.
			Limestone (local).
			Purple sandstone with conglomerate horizons, and sometimes a basal conglomerate.
			———(Profound unconformity).
Lower Dharwars.		Older metamorphic series.	Hornblende-schists, mica- and chlorite-schists, quartzites and jaspery quartzites.

¹ *Rec. Geol. Surv. Ind.*, LXVII, pp. 456–458, (1934).

² J. A. Dunn : *Geology of North Singhbhum, etc.* *Mem. Geol. Surv. Ind.*, LIV, p. 11, (1929).

H. C. Jones : *The Iron-ore deposits of Bihar and Orissa.* *Op. cit.*, LXIII, Pt. 2, p. 178, (1934).

In Southern Singhbhum the Iron-ore series retains its distinct sedimentary character, showing evidence of only a low grade of metamorphism. The same series has been traced into Northern Singhbhum where it is highly metamorphosed. The earlier part of the sedimentation is marked by sandstones and conglomerates containing occasional pebbles of jasper. Later sediments are fine pink to purple shales with an interlude during which the banded hæmatite-quartzites were deposited. The latest part of the cycle is marked by volcanism which gave rise to basic lavas, agglomerates and ash-beds, the centre of the main activity being situated in North Singhbhum. Minor centres seem to have been extant in South Singhbhum, where Mr. Jones ¹ has found basic lavas and tuffs interbanded with the upper shales.

The Iron-ore series is underlain by a highly metamorphosed series of rocks comprising hornblende-schists, quartzites, jaspery quartzites and some mica- and chlorite-schists with a profound unconformity separating the two. The series is mostly igneous, but may also include subordinate sedimentary rocks, the jaspery quartzites and mica-schists indicating the presence of the latter. The junction between the two series can be seen near Jagannathpur, south of Chaibasa, and further south in Keonjhar State.² The Lower Dharwars are also found as abundant inclusions isolated by, and enclosed in, the post-Dharwar granitic intrusions in the area south of Chaibasa.

The Gangpur series has nowhere been found in contact with the Lower Dharwars, so that their inter-relationship can only be conjectured; but there is little doubt that the Gangpur series represents a younger group of rocks than the latter. Between the Iron-ore series and the Gangpur series is the well-marked shear-zone of the Raghunathpali conglomerate. There are no clear evidences of thrust along this zone but from the structure of the region it appears that it is the middle part of the Iron-ore series that has come to rest on the conglomerate.

The separation of the Gangpur series as a unit distinct from the Iron-ore series in the Dharwarian sequence of Chota Nagpur is based:—*Firstly*, on the lithology, the former being characterized by well-developed horizons of gondite, dolomitic and calcitic marble and carbonaceous phyllite and the latter by banded hæmatite-quartzite; such calcareous, manganiferous or carbonaceous rocks as occur in the latter are of local development and devoid of the stratigraphical importance they attain in the former; *secondly*, on the relationship with the basic igneous rocks which are contemporaneous with part of the latter and

¹ H. C. Jones : *loc. cit.*, pp. 179, 207-211.

² E. H. Pascoe : General Report for the year 1926. *Rec. Geol. Surv. Ind.*, LX, p. 77, (1927).

are found only as intrusive sills in the former; *thirdly*, on structural and textural evidences, including the evidence of retrogressive metamorphism and of two periods of movement in the Gangpur series.

The above characters taken together show that the Gangpur series is older than the Iron-ore series. The existence of a conglomerate zone between them indicates a break in the continuous sedimentation, though the magnitude of this is indeterminable.

From the above discussion it will be clear that the Dharwars in Chota Nagpur can be regarded as comprising three units or series as shown below :—

Dharwar system.	Upper ..	Iron-ore series	..	(Sandstones, shales, phyllites, banded hæmatite-quartzite, and contemporaneous traps.)
	Middle ..	Gangpur series	..	(Gondites, marbles, and carbonaceous rocks.)
	Lower ..	Older metamorphic series.		(Hornblende-schists, mica-schists, and quartzites.)

III. THE DHARWARS OF THE NEIGHBOURING AREAS.

Rocks of similar age and characters occur in Orissa and the Eastern Ghats, in the Central Provinces and along a strip of country traversing the centre of Bihar. In the Central Provinces they are found extending from the Bilaspur district, through Balaghat, Bhandara and Nagpur, to Chhindwara. South of these areas are isolated patches in Chanda and Bastar, while to their north occurs a strip extending from Jubbulpore through the Narbada and Son valleys to Hazaribagh and Monghyr.

1. Orissa.

The stratigraphy of the Eastern Ghats region is too imperfectly known to be of much use in the present discussion. There are mica-schists and khondalites (quartz-garnet-sillimanite gneisses or schists) which form the bulk of the sedimentaries, and granitic gneisses, charnockites and younger granites, which form the igneous group.

Dr. Fermor¹ has divided Orissa into two regions characterized by non-garnetiferous and garnetiferous rocks, and which he has called the Chota Nagpur and Eastern Ghats facies respectively. The line of separation passes approximately W.N.W.-

¹ L. L. Fermor: Mineral Resources of Bihar and Orissa. *Rec. Geol. Surv. Ind.*, LIII, p. 242, (1921). (Illustrated by a separately published geological map.)

L. L. Fermor: *Rec. Geol. Surv. Ind.*, L, pp. 20-21, (1919).

wards from a point a few miles north-east of Cuttack, along the northern border of the Talchir coal-field to Rairakhol, thence westward to Padampur in the south-west of the Sambalpur district and finally southwards along the boundary of Orissa. The garnetiferous province or the Eastern Ghats facies is the one in which khondalites are abundant and occur in association with charnockite, all the rocks bearing the imprint of a high grade of metamorphism. In the greater part of this province, the general strike of the rocks is N.N.E.-S.S.W., but along the Mahanadi valley a distinct new strike, W.N.W.-E.S.E. (or N.W.-S.E.) is prevalent. Practically nothing is known about the sequence of the rocks here except that the khondalites may be regarded as very old para-schists. But in the adjoining districts of Madras it is known that the kodurite type of manganiferous rocks is always associated with khondalite. In some places there are also crystalline marbles occurring as lenses in the khondalites. I may therefore suggest that this association indicates affinities with the middle division of the Dharwars, though this will include only a part of the rocks occurring in this region.

2. Bilaspur-Balaghat.

In the Central Provinces, the main belt of Dharwars is characterized by occurrences of manganiferous rocks (gondites), the westernmost being at Kachi Dhana in Chhindwara and the easternmost at Jairasi in Balaghat.¹ Similar rocks have also been reported as occurring further east² near Ratanpur and Gorakona near Bilaspur, but apparently in a less metamorphosed condition.

The Chilpighat series of the Bilaspur-Balaghat area comprises felspathic grits, quartzites, slates, shales, and intercalated beds of trap. This series is regarded by Dr. Fermor³ as the equivalent of the Dharwars. The easternmost occurrence, east of Ratanpur, can be seen in the new geological map as wedging in between the granite-gneiss on the one hand and the Vindhya on the other. This is barely a hundred miles west of the westernmost extension of the Dharwar rocks of Gangpur State. The gneisses associated with the Chilpis may also include some highly metamorphosed equivalents of similar or older Dharwar rocks.⁴

According to R. C. Burton,⁵ who worked in the Balaghat region, the Chilpis occur as a long synclinal strip passing through

¹ *Mem. Geol. Surv. Ind.*, XXXVII, p. 308, (1909).

² *Rec. Geol. Surv. Ind.*, XL, p. 334, (1910).

³ *Mem. Geol. Surv. Ind.*, XXXVII, pp. 282-283, (1909).

⁴ *Rec. Geol. Surv. Ind.*, XLI, p. 20, (1911).

⁵ *Rec. Geol. Surv. Ind.*, XLVII, pp. 38-39, (1916).

Balaghat, Ukua, etc. They strike roughly N.E., and have a straight north-western margin and a sinuous south-eastern margin, the latter probably marking a plane of overthrust. Burton established the following sequence in the Chilpis:—

	Thickness.
Chilpighat series.	Phyllites, sericite-schists, and felspathic tuffs .. 2,500 ft.
	Blue slates and slaty quartzites .. 9-1,800 ft.
	Phyllites .. 3,500-5,000 ft.
	Manganese ore .. 0-50 ft.
	Phyllites and jaspered quartzites .. 200 ft.
	Basal conglomerates and grits (lying unconformably on a gneissic complex) .. 0-900 ft.

In the basal conglomerate are found pebbles of quartzite, gneiss, granite, phyllite, jasper, etc., some of which give abundant and unmistakable indication of derivation from pre-existing sedimentary rocks. In the Chilpis there are considerable thicknesses of basic rock, mainly as sills, but in Western Balaghat these basic rocks and the basal conglomerates become scarce.¹

The gneisses and schists at the base of the Chilpis show biotite- and muscovite-schists, quartzites, epidotic gneisses and occasional hornblende-schists, and contain also some manganese deposits in which are found various manganese silicates.² Dr. Fermor regarded these gneissose rocks as probably being the metamorphosed representatives of the Chilpis.

In the plains of Northern Balaghat, Burton found the following succession³ :—

Sonawani series.	Phyllitic schists and quartz-muscovite-schists.
	Felspathic quartzite.
	Quartz-muscovite-schist.
	Calc-gneiss and crystalline limestone. (Base not seen.)

The above succession, in which the limestones are associated with some manganese ores, was considered as unconformably underlying the base of the Chilpis with their basal conglomerate, and as probably representing an older facies of the Dharwars. To this series Burton proposed the name *Sonawani series*. Commenting on the geology of this area, Mr. C. S. Middlemiss wrote⁴ :—

‘In his account of the manganese-ore deposits of the Central Provinces, Dr. Fermor has distinguished two modes of occurrence of manganese-ores and associated manganese-silicate rocks. The chief mode is the gondite series of rocks situated near the base of the Chilpighat series; as an important but distinct mode of occurrence, he records the existence, in association with crystalline limestones, of manganese-ore deposits with associated spessartite, rhodonite, and piedmontite-bearing rocks. Since Mr. Burton assigns to the calcareous rocks a position near the base of his Sonawani series, we

¹ *Rec. Geol. Surv. Ind.*, XLV, p. 131, (1915).

² *Mem. Geol. Surv. Ind.*, XXXVII, pp. 694-695, (1909).

³ *Rec. Geol. Surv. Ind.*, XLV, p. 131, (1915).

⁴ *Rec. Geol. Surv. Ind.*, XLV, p. 132, (1915).

apparently have the interesting case of two distinct series of Archæan sediments, each distinguished by the deposition of manganiferous sediments close to the base.

In this area have also been found a biotite-gneiss and a granite both intrusive into the sedimentary series. The following general succession of rock groups in the Balaghat area can therefore be deduced :—

	Later intrusive granite and porphyritic gneiss.
	Older, more basic, biotite-gneiss, also intrusive into the older sediments.
Dharwars	{ Chilpighat series.
	{ Sonawani series (oldest).

3. Nagpur-Chhindwara.

In the Nagpur and Chhindwara districts of the Central Provinces a considerable amount of detailed work has been done by Dr. Fermor and his associates. The succession worked out by Dr. Fermor in the Chhindwara-Nagpur area has been confirmed by Messrs. W. D. West¹ and D. Bhattacharji in the Nagpur district. It has been named the *Sausar series*,² the different stages of which are given below :—

The Sausar series.

Stages (Fermor)	Stages (West)	Rock types
Ramtek ..	(?=Chorbaoli)	Sericitic quartzites.
Sapghota	Garnet-anthophyllite-schists, chlorite-schists, and magnetite-quartz-rock.
Sitapar ..	Sitapar ..	Hornblende-schists, garnet-amphibolites, and pyroxenite.
Bichua ..	Bichua ..	<i>Pure facies</i> : White dolomitic marbles with tremolite and diopside. <i>Impure facies</i> : Diopsidites, actinolite-schists, and schists with wollastonite, grossularite, scapolite, tremolite, and anthophyllite.
....	Junewani ..	Muscovite-biotite-schists with autoclastic conglomerates.
Chorbaoli ..	Chorbaoli (?=Ramtek).	Felspathic muscovite-quartz-schists and quartzites.
Mansar (Gondite)	Mansar ..	Muscovite-biotite-sillimanite-schists with lenticular beds of gondite and manganese ore.
Lohangi ..	Lohangi ..	Pink calcitic marbles and calciphyres. (Some manganiferous marbles.)
Utekata ..	Utekata ..	Banded calc-granulites.
....	Kadbikhera ..	Magnetite-biotite-granulites.

¹ *Current Sc.*, III, p. 140, (1934). Also a paper to be read at the current session of the Indian Science Congress.

² General Report for 1925. *Rec. Geol. Surv. Ind.*, LIX, p. 78, (1926).

4. *Bhandara.*

In the Bhandara district a triangular area of Dharwars is found occupied by rocks similar to those of Chilpighat. These beds, which comprise phyllites, mica-chlorite-schists, conglomerates, jaspers and contemporaneous traps, were grouped together under the name *Sakoli beds*¹ by V. Ball. The succession worked out by S. K. Chatterjee in this tract is shown below² :—

Sakoli series.	{	Crushed albite-microcline-quartzite.
		Phyllite and shale.
		Hæmatite- and sericite-quartzite, including some carbonaceous hæmatite-quartzite.
		Garnetiferous phyllite, chlorite-muscovite-schist, jaspilite, and hornblende-schist.

In the Nagpur-Bhandara area there are thus two series of rocks, the Sausars and the Sakolis, the latter being found forming a synclorium to the south of the former, and apparently being also younger.³

5. *Bastar and Chanda.*

In the less known region to the south of the above, P. N. Bose found Dharwarian rocks in Bastar State.⁴ Here the succession includes banded hæmatite-quartzites, quartzites, hornblendic and mica-schists, and extensively developed basic igneous rocks. The finely banded hæmatite-quartzite is a prominent member which apparently resembles that of South Singhbhum and also gives rise to beds of hæmatite towards the top. Mr. H. Crookshank's recent work in Southern Bastar⁵ indicates the presence of typical Iron-ore series with banded hæmatite-quartzites, associated with the *Benggal series* (andalusite-gneisses and quartz-schists) which probably represents an upper part of the Iron-ore series.

In the Chanda district⁶ also the same types of rocks have been observed, the hæmatite-quartzites, iron-ore, and associated basic intrusives being important members.

6. *Jubbulpore.*

To the north of the main areas in the Central Provinces, the Dharwars occupy an important portion of the Jubbulpore

¹ V. Ball : On the Geology of the Mahanadi basin and its vicinity. *Rec. Geol. Surv. Ind.*, X, pp. 180-181, (1877).

² *Rec. Geol. Surv. Ind.*, LXV, p. 107, (1931).

³ *Op. cit.*, LXII, pp. 132-133, (1929).

⁴ General Report of the Geological Survey of India for 1898-99, pp. 36-38, (1899).

⁵ *Rec. Geol. Surv. Ind.*, LXVIII, pp. 85-88, (1934).

⁶ P. N. Datta : On some iron-ores of Chanda. *Rec. Geol. Surv. Ind.*, XXXVIII, pp. 308-312, (1909).

H. H. Hayden : General Report of the Geological Survey of India for 1910. *Rec. Geol. Surv. Ind.*, XLI, pp. 81-82, (1911).

district. The assemblage of rocks here consists of phyllites and mica-schists, dolomitic and calcitic marbles, manganese-ores and iron-ores associated with banded hæmatite-quartzites. Sills of basic igneous rock are found. These rocks were originally described as Bijawars by Hacket, but Dr. Fermor¹ has since shown that they bear an unmistakable resemblance to the Dharwars and are therefore to be assigned to the latter. The original division of the formations into four stages, viz. :—

4. Chanderdip group.
3. Lora ,,
2. Bhitri ,,
1. Majhauri ,,

was modified by P. N. Bose, who put the Majhauri and Bhitri groups together. The above groups were admittedly made for convenience of description and do not represent distinct stratigraphic units. The banded hæmatitic rocks and manganese-ores occur in the Lora group, typified by the Lora range near Sehora. Iron and manganese ores occur to a large extent associated with each other, the latter being rather soft psilomelane and pyrolusite, and not of the gondite type.² The marbles, which include much dolomite, occur mainly in the lower stages. This assemblage of rocks bears an extraordinary resemblance to parts of the Chota Nagpur succession, and especially to the Iron-ore series. But the well-developed marbles of the Majhauri-Bhitri group, though not associated with gonditic rocks, may represent part of the Gangpur and Sausar series.

7. The Son valley and Bihar.

The Jubbulpore Dharwars are apparently continuous with those occurring along the Narbada and Son valleys to their E.N.E., culminating in the exposures of the Gaya, Hazaribagh, and Monghyr districts. Those occurring to the south of the Son valley of the Mirzapur district were regarded by Mallet³ as including two series with an unconformity between. These 'Transitions' grade into crystalline gneisses and schists forming sometimes injection-gneisses and show evidences of metamorphism as they approach the boundary of the gneisses. Vredenburg⁴ observed a general synclinal structure in them, the

¹ *Mem. Geol. Surv. Ind.*, XXXVII, p. 805, (1909).

² For descriptions, see : *Mem. Geol. Surv. Ind.*, XXXVII, pp. 803 et seq., (1909).

³ F. R. Mallet : On the Vindhyan series as exhibited in the North-western and Central Provinces of India. *Mem. Geol. Surv. Ind.*, VII, Art. 1, pp. 22-23, (1871).

⁴ R. D. Oldham, P. N. Datta, and E. Vredenburg : Geology of the Son valley in the Rewah State and of parts of the adjoining districts of Jabalpur and Mirzapur. *Mem. Geol. Surv. Ind.*, XXXI, Pt. 1, pp. 58-59, (1901).

southern boundary being more schistose than the northern. The different members found here include schistose quartzites with occasional conglomerate, slates, thin limestones, chlorite-schists, some jaspers, and basic lavas. This assemblage, forming the lower division, was called the 'Agori stage' by Medlicott. The slates and porcellanoid beds found in the centre of the synclinal fold are supposed to belong to an upper stage. The basic volcanics, which are of the nature of epidiorite and uraltite-diabase with uraltite, chlorite, epidote, pyrites, leucoxene, etc. are confined to the lower stage. As in Jubbulpore, these 'Transitions' were first thought to be the equivalents of the Bijawars, but at least a large part must be assigned to the Dharwars, in Dr. Fermor's opinion.¹

Mr. J. B. Auden² has recently recorded some exposures in this tract in which granite is distinctly intrusive into the phyllites of the 'Bijawars', and contain, in one case, xenoliths of amphibolised phyllite. It is practically certain that the granite is identical with that occupying the Ranchi plateau and other parts of Chota Nagpur, where it belongs to the period of post-Dharwar diastrophism. The granite being thus pre-Cuddapah in age, the so-called Bijawars of the Son valley must be equivalent to a part of the Dharwars. Since banded jaspers and associated epidiorites are an integral part of these, they should be regarded as similar to the Iron-ore series of Singhbhum. So far as is known, no older rocks corresponding to the Gangpur series is present, since no important marble beds or manganese-ores have been recorded from this region.

The exposures further east in Bihar, as in the Kharakpur, Gidhaur, Sheikhpura and other hills, are mainly composed of quartzites, mica-schists, and slates with a general E.-W. or E.N.E.-W.S.W. strike. It is not known to which part of the Dharwars these are to be assigned, but probably they may be correlated with part of the Iron-ore series.

IV. CORRELATION.

Having briefly reviewed the distribution and composition of the Dharwars in Bihar and Orissa and the Central Provinces, I may now attempt a correlation of them. For this purpose we have to depend entirely on lithological resemblances supported to some extent by structural evidence. A few years ago, my colleague, Dr. J. A. Dunn,³ published a correlation of the Archæans of Peninsular India, acting probably on the sugges-

¹ J. B. Auden : Vindhyan sedimentation in the Son valley, Mirzapur district. *Mem. Geol. Surv. Ind.*, LXII, Pt. 2, foot-note by L. L. Fermor on p. 145, (1933).

² *Ibid.*, pp. 145-146.

³ J. A. Dunn : The Archæan rocks of Peninsular India. *Report of the 18th meeting of the Australasian Assoc. Adv. Sc.*, Vol. XVIII, Section C, pp. 291-311, (1928).

tion¹ that the gondite series may prove helpful in such a venture. The result has not however proved satisfactory since all the known manganiferous horizons were regarded as equivalent or homotaxial, and the fact that more than one manganiferous horizon may be encountered in the Archæan succession was not considered. The attempt presented here will, I hope, prove more acceptable.

I have suggested above a three-fold division of the Dharwars in the Chota Nagpur region (*vide* p. 181 (7)), viz. :—

Upper Dharwars	..	Iron-ore series.
Middle „	..	Gangpur series.
Lower „	..	Older metamorphic series.

How far the lower division is represented in other areas, it is impossible to say at present. As already remarked, parts of the gneissose series in the Central Provinces may however include some rocks similar to these in characters and age. More data than we possess at present, will be required in settling this point.

The middle division is characterized by the gonditic rocks and crystalline marbles. This series is best developed in the Gangpur State in Bihar and Orissa and in the Sausar-Ramtek region of the Central Provinces, though the Sausar series evidently represents a more complete succession than the Gangpur series. In the latter, there are gondites with overlying dolomitic marbles, as in the former. But no rocks directly underlying the gondites are seen, since these occupy the centre of the anticline. The Sonawani series in Balaghat seems to be another representative of this division, in which, however, the manganese-ores are intimately associated with the marbles and calc-gneisses. In the Jubbulpore district the lower division exposed—the Bhitri-Majhauhi group—shows marbles but no gondites. This may therefore represent a portion of the Sausar series, the gondites being either not developed or not exposed. In the Son valley region, since no rocks of the gondite type has been noted and since the limestones are not important enough to be compared with those of the Sausars, this division may be taken as non-existent. The association of kodurites, and sometimes marbles, with the Khondalite series of the Eastern Ghats, would indicate their inclusion here, though it must be admitted that our knowledge of the geology of the Eastern Ghats region of Orissa, and even of Ganjam and Vizagapatam, is meagre.

The younger Dharwars, represented typically by the Iron-ore series, comprise banded iron-ore-jaspers and sills and contemporaneous lavas of basic composition as typical members. The metamorphism of these is in general of a low grade, but may occasionally be more intense as in North Singhbhum. Such

¹ E. H. Pascoe : General Report of the Geological Survey of India for the year 1925. *Rec. Geol. Surv. Ind.*, LIX, p. 80, (1926).

higher grade metamorphism would produce hæmatite- and magnetite-schists. The iron-ores may also be associated with manganese-ores such as occur in Singhbhum and Keonjhar in Bihar and Orissa and in Jubbulpore in the Central Provinces and in Shimoga in Mysore. But typical gondite does not occur in this division. The manganese-ores are to be regarded as segregations from the shales and ferruginous rocks in which they occur. Subordinate limestones are also found, and it is but rarely that they show the development of high crystallinity or the presence of calc-silicates. The equivalents of the Iron-ore series in the Central Provinces will therefore be seen to be represented by the Chilpighat series of Bilaspur and Balaghat, the Sakoli series in Bhandara, the Transitions with typical iron-ore-quartzites in Bastar and Chanda, the Lora and Chanderdip groups in Jubbulpore and the Transitions of the Son valley. In all these, banded hæmatite-quartzites or jaspers are more or less typically developed, and intrusive and extrusive basic rocks are found. These last are typically epidiorites and amphibolites and no more preserve their original igneous character as do the basic rocks of later age. Whether the rocks of Gaya, Hazaribagh, and Monghyr are assignable to this division is not clear, but they may be tentatively put here.

The striking similarity of lithological characters of the formations in the region considered will generally be conceded. This would point to similar conditions of sedimentation and like sources of sediments. The metamorphic, tectonic, and igneous history are also comparable in the different areas in this region.

It will not be out of place here to indicate briefly the possible application of the scheme of classification advocated here to the two other important areas of Dharwars in India. From a general survey of this system of rocks, it appears that areally, the upper division (Iron-ore series) is extensively developed not only in Bihar and Orissa and the Central Provinces but also in South India, where there are banded iron-ore rocks in the Dharwar, Bellary, Mysore, and Salem areas. The iron-ore in the latter two is however dominantly magnetite and martite, evidently attributable to metamorphism and to the effect of igneous intrusions. A good part of the succession found in South India would therefore be assignable to the Upper Dharwars. The manganese-ores and the rocks from which they are derived are of the type associated with the Iron-ore series and not of the gondite type, except in one place. This exception is found in the Sakarsanhalli area, of which a recent description has been published,¹ and where the manganese-marble association is characteristically present, as in the Sausars.

¹ M. B. Ramachandra Rao and K. Sripada Rao: *Bull. Mysore Geol. Dep.*, No. 14, (1934).

The Dharwars of Mysore are divided into a lower Hornblendic Division and an upper Chloritic Division. Though the Mysore Geological Department regards practically all the rocks—including the banded iron-ore-jaspers and mica-schists—as of igneous origin, there are reasons for believing that at least an appreciable part of the succession was originally sedimentary. The hornblendic division, if mainly igneous, may be the equivalents of the Lower Dharwars of Chota Nagpur. Except for the Sakarsanhalli rocks, how much of the Middle Dharwars is represented here is not possible to indicate. The Dharwar bands to the north of Mysore are mainly of the Iron-ore series type, the older divisions being only meagrely represented, if at all. The igneous history of the South Indian region is also more complex than that of Bihar and Orissa.

The Archæans of Rajputana overlying the banded gneissic complex have been divided by Dr. A. M. Heron into three main groups, the Aravalli system, the Raialo series and the Delhi system. Lithological comparisons are even more difficult with Rajputana than with South India, and it is probable that this region had a distinct sedimentary history. It has now been established¹ that the Aravallis are identical with the Champaners, as they have been connected up by continuous mapping. Since manganiferous rocks of the gondite type have been observed in these, as at Jothvad in Narukot State and in Jhabua (though the deposits at Sivarajpur² are referred to doubtfully as of superficial origin), they can be correlated with the Sausars. Part of the Aravallis and even of the gneissic complex may contain the equivalents of the Lower Dharwars.

With regard to the Upper Dharwars, the lithological criterion used here breaks down. If however we regard the sandstones and the generally impure and more or less locally developed limestones of the Iron-ore series as the equivalents of the quartzites and calc-rocks of the Delhis, and assume a resemblance, though remote, between the banded jaspers of Singhbhum and the hornstone-breccias of Rajputana (which contain iron-ore and also manganese-ore segregations) we may consider the Delhis as fitting into the Upper Dharwars. Since, however, the resemblances are far from satisfactory, the possibility of the Delhis representing a post-Dharwar and pre-Cuddapah system, pointed out by Dr. Heron,³ still remains as a useful solution of the question.

V. TECTONICS.

The general strike of the rocks of Gangpur varies between E.-W. and E.N.E.-W.S.W., the latter direction being nearer the

¹ *Rec. Geol. Surv. Ind.*, LXVIII, p. 25, (1934).

² *Mem. Geol. Surv. Ind.*, XXXVII, pp. 654, 656, (1909).

³ *Mem. Geol. Surv. Ind.*, XLV, Pt. 1, pp. 110-116, (1917).

average. This is continued into North Singhbhum. To the south, as we enter into the neighbouring districts of Sambalpur, Bamra and Bonai, there is a gradual change till a W.N.W.-E.S.E. direction is attained. This direction of strike continues into Western Gangpur on the one hand, and down the Mahanadi valley to the east, on the other. In South Singhbhum, the strike becomes N.N.E., as is typically seen in several of the iron-ore ranges.

The major trend lines of Bihar and Orissa, which the above reflect, have been admirably summarized by Dr. Fermor¹ in a paper published several years ago :—

‘In the northern portion of this tract, viz. in South Bihar and the Chota Nagpur plateau, the average direction of the Archæan fold-axes varies between E.N.E. and E., and there is no doubt that the hill ranges of South Gaya, North Hazaribagh and Monghyr, and the plateaux of Hazaribagh and Ranchi are to be regarded as forming the geological extension into this province of the Satpura range of the Central Provinces. In conformity with the average Archæan strike, the coal-fields of Palamau and the Damodar valley are aligned along an E.-W. belt, extending from the Hutar field in the west to the Raniganj field on the eastern boundary of the province.

The geology of large portions of the Orissa Feudatory States is almost unknown but the Archæan rocks in this tract appear to be much less regular in their disposition, probably due in part to the encroachment on the southern edge of the province of the Eastern Ghats system of mountain folding with its general N.N.E. strike. It is found that the Eastern Ghats ranges extend as far north as Athmallik and Angul in Orissa on the north side of the Mahanadi river, where, however, they have lost their N.N.E. strike and have swung round to a general E.S.E. strike parallel to the line of junction between the two facies of Archæan rocks. The Talchir coal-field overlies this line of junction and, with its E.S.E. alignment, again illustrates the rule as to the parallelism between the strike of the Gondwanas and that of the Archæans. The point is illustrated once again to the north of Sambalpur, where the abnormal N.W.-S.E. strike of the Archæans is reflected in the strike of the Raigarh-Hingir (or Rampur) coal-field lying partly in this province and partly in the Central Provinces.’

The Satpura strike is therefore prevalent over the whole of Bihar and includes the greater part of Gangpur and North Singhbhum. The rocks of South Singhbhum and the area to its east are aligned parallel to the Eastern Ghats strike. The third direction, which may be called the ‘Talchir strike’ for brevity, seems to be equally important and stretches right along the Mahanadi valley and includes South-western Orissa. The Eastern Ghats and Talchir strikes interfere with each other at some distance north of the Mahanadi valley, for instance, near Balrampur between the Mahanadi and Brahmani in South-eastern Orissa, and in southern and western parts of Gangpur. At the northern end of the Eastern Ghats, the Archæans become

¹ L. L. Fermor : The Mineral resources of Bihar and Orissa. *Rec. Geol. Surv. Ind.*, LIII, pp. 241-242, (1921).

covered up by Tertiary rocks. Near here, in Dhalbhum, the rocks of the Copper Belt swing round to the south-east. Dr. Fermor has remarked¹ about the peculiarity of the strikes around the granitic mass of Mayurbhanj State which lies to the south of Dhalbhum. Roughly centred around Karanjia in Mayurbhanj State, the Archæan rocks show tangential strikes. Of those mentioned however, only the N.W.-S.E. strike of the Dhalbhum copper belt is peculiar, the others corresponding to either of the two strikes characterizing the country near about them. There is nevertheless the possibility that the circular area mentioned above, which is now mostly occupied by younger granite, may originally have been occupied by an old land mass, the sediments deposited around which accommodated themselves with tangential strikes when compressed by the three major movements whose directions are marked by the three prevalent strikes of Bihar and Orissa.

With regard to these strike directions—viz. the Chota Nagpur, Eastern Ghats and Talchir, it is not possible to say anything about their relative ages in the present state of our knowledge, since the greater part of Orissa has yet to be mapped geologically. In the Gangpur series, for instance, there are evidences of two movements in the garnetiferous schists, the later one, which has affected the softer constituents, being the Satpura strike. The earlier one is to some extent indicated by the orientation of porphyroblasts (particularly garnet and biotite), but to determine this, the collection of oriented specimens in the field and the microscopic study of oriented slices from them will be necessary.

It may however be admitted that the three compressions which have given rise to the main trends are older than the post-Dharwar granite, since the large masses of this granite occurring in Ranchi, Singhbhum, and Keonjhar (so far as I know from personal observations) are unaffected by any of them. Whether all belong to the epoch of post-Dharwar diastrophism, or any of them to older periods, will have to be settled in the future by a study of structures both on regional and on microscopic scales.

In the Central Provinces again, in the area between Chhindwara, Bilaspur and Bhandara, three main trends are apparent. On the north is the continuation of the Satpura strike, which Mr. D. Bhattacharji has named here the 'Ramtek compression' after the compressive movements which produced it. There is a N.W.-S.E. strike on the south-western side, referred to as the 'Pauni compression' trend. There is a third with N.-S. (varying to N.N.E.-S.S.W.) trend referred to as the 'Partabgarh compression'. All the three strikes are, according

¹ *Ibid.*, p, 243.

to Mr. Bhattacharji, arcuate, with their convexity facing the centre of the triangular area, and all have affected the Dharwarian rocks. The strip of rocks extending from Jubbulpore to Monghyr has the characteristic Satpura strike.

It will be seen that the three trends in the Central Provinces can be roughly matched with those of Bihar and Orissa, though not strictly parallel to them. Beyond calling attention to this fact, I am not in a position to suggest whether similar pairs of trend lines are in any way closely related to each other.

VI. SOME SEDIMENTARY TYPES IN THE DHARWARS AND THEIR GENESIS.

As will be apparent from what has been said above, the Dharwars include some common and some peculiar types of sediments. I shall now consider the latter, taking my examples as far as possible from the area with which I am familiar.

1. *The Marbles.*

The dolomitic and calcitic marbles in the Gangpur area form continuous beds for long distances over which they maintain a fairly uniform thickness. The regularity of the beds leaves little room for doubt as to their marine sedimentary origin. R. A. Daly¹ has advanced reasons for considering the pre-Cambrian limestones (a good deal of which is dolomitic in character) as being mainly chemical precipitates, formed at a time when the scavenging system was yet to be established in the oceans, and when the animals had not evolved any hard parts to the making of which much calcium and magnesium is at present abstracted from the ocean waters.

As pointed out by E. Spencer,² the limestones at Raipura and other places in Gangpur contain some carbonaceous, presumably organic, matter, because of which they are frequently grey in colour. Whether this is to be taken as evidence for the existence of organisms in that remote past may be a debatable question, but I am inclined to believe that such is highly probable. In this connection it is interesting to note that Mr. D. N. Wadia is of the opinion that the carbonaceous matter in the grey and often black limestones and crystalline marbles occurring in the Salkhala series of the North-West Himalaya is of organic origin. Recent studies have shown that limestones form in shallow marine areas, the precipitation being helped by low

¹ R. A. Daly: The limeless ocean of the pre-Cambrian time. *Amer. Jour. Sc.*, XXIII, pp. 93-115, (1907).

² E. Spencer: Albite and other authigenic minerals in limestone from Bengal. *Mineral Mag.*, XX, pp. 366-367, (1925).

organisms of the type of bacteria.¹ Algal limestones of different ages² are also now recognized as being extensively distributed. Hence, though these carbonate rocks may be admitted to be mainly of chemical origin, it seems probable that some low organisms may have contributed directly and indirectly to their formation. The preservation of organic structures is of course not to be expected, because of the destructive effect of subsequent metamorphism.

Some calcareous horizons, which are generally impure, occur also in restricted areas in other parts of the Dharwar sequence in Chota Nagpur. But they do not attain the same importance as the main beds of the Gangpur series.

2. *The Carbonaceous Phyllites.*

There are two main horizons of carbonaceous phyllites in the Gangpur series, one below and the other above the marbles. A few thin beds occur also in the Iron-ore series in South-eastern Gangpur. The rocks vary from soft black phyllites to thinly banded dark quartzites, the latter resembling the banded jaspers in constitution to a remarkable degree. The carbon in these is associated with ferruginous (limonitic) matter, and is found to be more or less evenly distributed in the different layers as fine dusty and clotted patches. Carbonaceous matter is also found in much smaller proportion in the adjacent mica-schists.

A point of some importance is that the younger of the two carbonaceous horizons is in several places associated with sills of epidiorite, such an association not being found in the case of the older horizon. At the same time, the banded quartzite is much more abundant in the latter than in the former.

Lenticular beds of similar carbonaceous rocks have been found in some places in Northern Singhbhum, where, according to Dr. J. A. Dunn, they are associated with basic lavas and pyroclastics. Basing his argument mainly on this, Dr. Dunn has stated³:

‘The association of these carbon-bearing phyllites with pyroclastics is too well marked to be passed over without comment. Their origin bears also on the origin of the black phyllites along the northern and southern boundaries of the epidiorites, which are also associated with phyllites that may be traced into volcanic tuffs. Their persistent association with pyroclastic rocks points to their pyroclastic origin also, and suggests that they are completely altered fine tuffs or volcanic dust. If this is so, the question of the origin

¹ G. S. Drew: On the precipitation of calcium carbonate in the sea by marine bacteria. *Carnegie Inst., Washington, Publ.*, 182, pp. 7-45, (1914).

K. F. Kellerman and N. R. Smith: Bacterial precipitation of calcium carbonate. *Jour. Wash. Acad. Sc.*, IV, pp. 400-402, (1914).

² E. J. Garwood: *Geol. Mag.*, X, pp. 440-446, 490-498, 545-553, (1913).

³ *Mem. Geol. Surv. Ind.*, LIV, pp. 46-47, (1929).

of the carbon that is so frequent a constituent of them arises. Accepting the fact that these rocks are Archæan in age, can an organic origin be postulated for this carbon? If, however, it is of organic origin, why is it only found here in association with volcanic material? Its very association points to an origin under volcanic conditions. Accepting this connection, two hypotheses may be advanced in regard to its deposition:

- (1) That it is a sub-aerial precipitation of carbon due to the combustion of volcanic gases containing hydrocarbons and carbon-monoxide, in the immediate neighbourhood of the volcanic foci Carbon is one of the products of combustion under favourable thermal conditions, and is carried down with the accompanying volcanic dust.
- (2) That it is a fumarolic deposit formed towards the close of volcanic activity by the break-down of the gases permeating the sediments or volcanic dust associated with the flows . . .

Under the conditions envisaged by Dunn, the carbon-bearing gases must have evenly permeated the large volume of sediments and tuffs and subsequently been reduced to the elemental condition. Such a hypothesis is of doubtful validity if applied to beds which are found to be far away from the volcanic foci and which show no igneous associations. I have not observed anything in Gangpur which is of pyroclastic nature. Neither am I convinced that some of the material which has been thought to be a carbonaceous tuff in North Singhbhum is a tuff at all. For, I have frequently observed weathered carbonaceous phyllite having an ashy or scoriaceous appearance in widely separated localities, whether associated with epidiorites or not. Lastly, since the Gangpur series is older than the Iron-ore series and since the volcanism was contemporaneous with the topmost beds of the latter, an igneous origin for the carbon in the former seems scarcely acceptable.

With regard to the close connection in some places in Gangpur between basic intrusives and carbonaceous phyllites, it would appear that the latter afforded a zone of weakness which was easily penetrated by the basic magma. The carbonaceous phyllites are soft, friable and porous, and have been silicified extensively in places. The younger zone, with which the igneous rock is exclusively associated, was probably in a less compact condition than the older. Moreover, the greater abundance of quartzites in the older zone must have been less favourable for permeation by the magma.

The regularity and persistence of the beds over long distances is more consistent with a sedimentary, rather than a pyroclastic, origin. That is to say, the carbon is to be attributed to an organic source. Admittedly, there must have been an enormous period of time before the appearance of the prolific and highly developed Cambrian fauna, during which several primitive forms, both animal and plant, had time to flourish and evolve. Evidence of these forms is however entirely lacking, because of the absence of hard parts which could be preserved

and because of the destructive action of metamorphism in which most of the pre-Cambrians have been involved.

Similar rocks occur in various parts of India in formations of a like age. I have seen specimens from the Salkhala and Jutogh series of the Himalaya which can be exactly matched with those from Gangpur. The Sakolis of the Central Provinces, the Merguis and the Chaung Magyis of Burma also contain carbonaceous rocks. In none of these cases, however, has a volcanic origin been suggested for the carbon by the geologists familiar with them. On the other hand there is opinion in support of organic origin.

The main carbonaceous deposits of later times are found in the form of coal and coaly shale. Coal is now recognized as composed of a colloidal base in which plant debris and clay or other mineral matter is embedded.¹ The deposits with which we are concerned here may consist of similar carbonaceous substances formed from the decay of organic matter, deposited in a colloidal condition together with much clay. The banded quartzites contain thin layers of cherty silica impregnated, to a varying extent, with carbon. Their resemblance to the banded jaspers would point to their having been formed under conditions of rhythmic precipitation.

I believe therefore that the evidence for an organic origin of the carbon content of these rocks is strong, and that the association of basic volcanics is but an accident. That is to say, only in North Singhbhum a period of deposition of carbonaceous clay happened to coincide with one of contemporaneous volcanism.

3. *The Manganiferous Rocks.*

Manganiferous rocks of the gondite type occur in a series of thin elongated lenses intercalated with the phyllites and mica-schists of the basal part of the Gangpur series. The mineral composition differs somewhat in the different exposures, those in the west being rich in silicates. The various manganese minerals are seen, under the microscope, to have been altered to manganese ores in varying degrees. In their constitution, mode of occurrence and alteration they are exactly similar to the gondites of the Central Provinces, so that the processes outlined by Dr. Fermor² with regard to their mode of formation can be accepted. Their occurrence amidst para-schists points to their original sedimentary nature. The purity of some of the ores and the general absence of secondary structures in them show that a part of the original deposit is now found practically in the same condition as when it was deposited, except for

¹ See, for instance:—L. L. Fermor: *Rec. Geol. Surv. Ind.*, LX, pp. 345-350, (1928).

² *Mem. Geol. Surv. Ind.*, XXXVII, pp. 364-365, (1909).

compaction and crystallinity. As pointed out by the same authority,¹ these ores do not owe their origin to any process of superficial enrichment.

An entirely different type of manganese-ore deposits occurs in the Iron-ore series near Chaibasa and Bara Jamda in Singhbhum and in certain places in Keonjhar. These are distinct from the gondite type and are to be regarded as due to concentration of the manganese content of the shales and other strata in which they occur. In some places they are associated with lumps and boulders of limonite and hæmatite which are also of the same origin. The ores occur at various horizons and show secondary structures characteristic of replacement and superficial enrichment. It will therefore be clear that these deposits represent an epigenetic type in contrast with the mainly syngenetic ore of the gondite series.

Manganese ores of the two types mentioned here are also found in other countries. In Minas Geraes in Brazil² one type is associated with manganese carbonate, garnet and other silicates, forming a series of lenses in the gneissic complex. Miller and Singewald compare this to the gondite of India, and state that the Brazilian rocks are dominantly in the form of carbonate and average much lower in silica than their counterpart in India.³ In the second type the ore occurs in connection with dolomitic limestone in certain zones of the Itabira formation. These authors think that the ore is a product of replacement of the limestone.⁴ Scheibe⁵ has however adduced evidence to show that the manganese was deposited with the limestone either as carbonate or colloidal oxide, such carbonate association being said to be rare in the case of the iron-ore of the same formations.

In the Lake Superior region as illustrated by the Cuyuna district, there are two ore horizons, the lower of which is dominantly manganiferous and the upper ferruginous, while both are rich in manganese in their basal portions.⁶ These would therefore show a close resemblance to the Iron-ore series type.

The ores of the Gold Coast Colony⁷ in West Africa, which occur in the Archæan Birrim series, seem to be of the gondite type. They contain manganese silicates and are associated with metamorphosed carbonaceous, ferruginous, and aluminous

¹ *Rec. Geol. Surv. Ind.*, XLI, p. 3, (1911).

² B. L. Miller and J. T. Singewald: *The Mineral deposits of South America*, pp. 177-188, New York, (1919).

³ *Op. cit.*, p. 187.

⁴ *Op. cit.*, pp. 179-180.

⁵ E. A. Scheibe: *Über die Entstehung brasilianischer Itabirite. Zs. Deuts. Geol. Ges.*, Bd. 84, p. 46, (1932).

⁶ Carl Zapffe: *Geologic structure of the Cuyuna iron district. Econ. Geol.*, XXIII, pp. 612-646, (1928).

⁷ D. W. Bishopp and W. J. Hughes: *Geology of the manganese-ore deposits in the Gold Coast Colony and in Ashanti. Inst. Min. Met. Bull.*, No. 304, (1930).

clay sediments. They include both primary ores and those due to secondary enrichment.

The manganese ores of Postmasburg¹ in the Union of South Africa are regarded as due to metasomatic replacement of the basal portions (conglomerate, breccia, and shales) of the Gamagara series which lies unconformably over the Griquatown series of the Transvaal system. The Griquatown series, containing the banded ironstones, is the analogue of our Iron-ore series. The limestones of the underlying Campbell Rand series (which also forms part of the Transvaal system) which contain up to 2 per cent. of manganese, are regarded as having provided the ore now found in the Gamagara series, through the agency of aqueous solutions. The ore is in part coarsely crystalline and in part micro-crystalline or amorphous. Its epigenetic character does not seem to be in doubt. Whether any of the manganese was derived from the banded ironstones of the Griquatowns is not clear, though this seems probable.

My purpose in bringing in these foreign deposits is to point out that there are two main types as in India. Attention may also be drawn to the fact that in a number of cases the deposition of manganese was closely connected with that of the carbonate rocks, perhaps as a manganese or manganiferous carbonate, though in some cases it may have taken the form of an oxide or hydroxide.

4. *The Banded Hæmatite-quartzites.*

There are several well-marked ridges of hæmatite-quartzites capped by excellent high grade iron-ore in South Singhbhum and in parts of Keonjhar and Bonai. So far as known, all these represent a single stage of sedimentation, but repeated by folding along a N.N.E.-S.S.W. axis. The iron-ore deposits and a part of the country in which they occur form the subject of a recently published Memoir by Mr. H. C. Jones.²

The pre-Cambrian banded ironstones have been the subject of much discussion. They are of great economic importance and occur in several countries—the Lake Superior region of North America, Brazil, Venezuela, Sierra Leone, South Africa, India, and Manchuria. They have received different names such as taconite, jaspilite, and ferruginous chert in North America, itabirite in Brazil, calico-rock in South Africa, and banded hæmatite-jasper (or quartzite) in India. The iron ores associated with them are mostly in the form of hæmatite, though magnetite is also found in some as a result of metamorphism.

The striking peculiarity of these consists in the fine banding

¹ L. T. Nel: The geology of the Postmasburg manganese deposits. *S.Afr. Geol. Surv.*, (1929).

² *Mem. Geol. Surv. Ind.*, LXIII, Pt. 2, (1934).

brought about by the presence of alternating thin layers of cherty quartz, jasper, and iron ore. In Orissa, they attain a general average thickness of over 1,000 ft., while in places Mr. Jones has estimated a thickness of about 3,000 ft. The silica, though apparently cherty, is almost always found to be micro-crystalline, and occasionally even somewhat coarse. But there is little doubt that the crystallinity has been developed after the consolidation of the original sediment. The different layers vary in colour from white, through grey and various shades of red and brown, to black. Besides quartz, the minerals found in them include hæmatite, magnetite, martite, siderite or other carbonate, and amphiboles of the grunerite series. The last are generally attributed to the influence of thermal or regional metamorphism. The rocks are generally highly folded and contorted, revealing all stages of folding and faulting from regional to microscopic scales. The microstructures may however be the result of secondary changes.

The origin of these rocks has been discussed by several eminent geologists who have studied them in different parts of the world. A summary of these views has been given recently by Dr. Percival.¹

The deposition of these peculiar banded rocks has not, however, been repeated in post-Cambrian times. That they are sedimentary in origin, is now generally agreed. The difference of opinion is with regard to the sources of the material and the actual mode of deposition. The deposition may be admitted to be due to chemical precipitation, there being very little admixture of mechanical detritus. The alternation of the fine layers has probably been brought about by a process akin to the Liesegang phenomenon. E. S. Moore and J. E. Maynard² have conducted experiments which go to show that colloidal solutions containing ferric hydroxide and silica, stabilized by organic matter, can produce similar deposits under the influence of electrolytes of more or less the same character and concentration as are found in the sea. Van Hise and Leith have, in their well-known monograph on the Lake Superior deposits, advocated a submarine volcanic source to account for the large quantities of iron present, the occurrence of contemporaneous basic volcanic rocks being relied on for supporting the argument. Dr. Percival postulates a similar source for the iron in the Noamundi (Singhbhum) deposits, since here also basic igneous rocks and some shales thought to be tuffaceous in character are found in their proximity. In my discussion of Dr. Percival's paper I

¹ F. G. Percival: The Iron-ores of Noamundi. *Trans. Min. Geol. Inst. India*, XXVI, pp. 169-252, (1931).

² E. S. Moore and J. E. Maynard: The solution, transportation, and precipitation of silica. *Econ. Geol.*, XXIV, pp. 272-303, 365-402 506-527, (1929).

have stated that the ordinary sedimentary sources and processes may be sufficient to account for all the iron, especially as the period of volcanism in Singhbhum, which belongs to the uppermost stage of Iron-ore series (as has been shown by Dr. Dunn), is younger than the deposits constituting the banded rocks.

In two recently published papers Carl Zapffe¹ stresses the fact that ordinary processes of weathering of rocks can contribute enough iron and silica for the deposition of such strata. He has mentioned several instances where the reservoirs and lakes which formed the source of water supply of some European cities showed, at different times, enormous and unaccountable increase in the precipitates of iron and manganese, derived from surface waters. In ordinary ground-waters iron and manganese occur mainly as bi-carbonates and the iron is deposited easily by aeration or oxidation, helped by a slightly acid reaction of the solution. The manganese is deposited from slightly alkaline solutions in the presence of much oxygen. When the solutions are rich in carbon dioxide, the carbonates are formed instead. In his studies, undertaken with reference to the elimination of iron and manganese from the water supply of Brainerd in Minnesota, Zapffe found a striking similarity between the precipitates from the water supply and the manganese-bearing iron-formation :

'The similarity is not confined merely to mineral compounds but also to their relative proportions. It is to be noted that the minerals in this precipitate are oxides; carbonates are few and silicates are lacking.'²

He proceeds to say that conditions in open seas would mostly favour the precipitation of the oxides since there is generally a plentiful supply of oxygen. The carbonates will form only when the quantity of oxygen present is inadequate. With a diminishing supply of oxygen, iron-oxide and then manganese oxide will form first, and thereafter* the carbonates, the manganese carbonate taking precedence over the iron carbonate.

'Inasmuch as conditions under which oxides on the one hand and carbonates on the other are deposited are now clear and well understood, it is not an abuse of the imagination to suppose that under natural conditions in open seas oxides may have been deposited in one phase and carbonates in the other; or that these two phases of deposition may have operated simultaneously in different parts of the deposition area. Finally, the conditions in a given area may oscillate rapidly from one phase to the other just as variations in hydrogen-ion concentration can determine whether both iron

¹ Carl Zapffe : The deposition of manganese. *Econ. Geol.*, XXVI, pp. 799-832, (1931).

Carl Zapffe : Catalysis and its bearing on the origin of Lake Superior iron-bearing formations. *Econ. Geol.*, XXVIII, pp. 751-772, (1933).

² *Op. cit.*, p. 767.

and manganese are to be deposited or only iron. Inasmuch as it appears that the conditions that determine the oxide deposition are now dominant in the open seas, it seems probable that much of the iron formation which is oxidised but unleached, as we see it now, is in that respect an original phase.¹

The sequence of the process is then pictured as follows :—

‘Silica, its (the water’s) main constituent, went down as such ; the iron and the manganese as hydrated oxides or carbonates ; the lime and magnesia as carbonates ; all in accordance with simple laws of chemistry, and nothing in apparent contradiction with them. When the iron formations were buried by over-lying sediments and later deformed or intruded, anamorphic changes took place, the extent and completeness of which varied from one locality to another in accordance with the anamorphic conditions, whether incipient, moderate or severe. The anamorphic changes were in the direction of dehydration, deoxidation, decarbonation, and silication. All these principles are illustrated in the Biwabik formation of the Mesabi district.’²

Zapffe is definitely of the opinion that the iron-silicate called greenalite, which has been supposed to be an original mineral formed somewhat after the manner of glauconite, is of secondary origin. It lacks the foreign nucleus characteristic of glauconite. A low grade metamorphism is considered sufficient for the formation of the mineral. Commenting on the supposed influence* of basic eruptives as the source of the iron in the Lake Superior region, he states that the Middle Huronian, which contains some of the best known iron-ore deposits, is unassociated with contemporaneous volcanics, the igneous rocks in it being acid intrusives. It is only in the Upper Huronian that the basic eruptives occur.

It would therefore appear that sedimentary processes could account for the formation of these banded hæmatite-quartzites. A volcanic source for the iron can be considered only if contemporary volcanic activity can be definitely proved. The non-repetition of such strata during later geological epochs certainly indicates that the conditions and processes of the pre-Cambrian times have been peculiar ; but a volcanic source need not necessarily be postulated to account for this peculiarity.

Zapffe’s contributions help us in understanding the conditions under which iron and manganese have been deposited together or separately, as oxide or as carbonate, in the pre-Cambrian era. In India there are two main periods of sedimentation, the earlier one (Middle Dharwar) being marked by dominantly manganiferous, and the later one (Upper Dharwar) by ferruginous, deposits. The frequent association of manganese ores with carbonate rocks has already been pointed out. These therefore seem to have been laid down during a period marked by an abundance of carbon-dioxide or paucity of oxygen

¹ *Op. cit.*, pp. 768-769.

² *Op. cit.*, p. 770.

in the atmosphere and in the ocean basins. During the later period of iron-ore deposition, an adequate supply of oxygen would seem to have been available, since the iron-ores are mainly in the form of oxide. Though such a generalization appears to be admissible, it should be realized that the conditions may have varied from place to place and during the progress of time. About the other factors which have helped to bring such large quantities of iron and manganese into solution, and have controlled their distribution and deposition, we have as yet only meagre knowledge.

With regard to the iron formations in South India, the occurrences in Dharwar and Bellary, described by Foote¹ and Maclaren², have a close resemblance to those of the Iron-ore series. Further south in Mysore, magnetite or martite seems to be more common than hæmatite. The opinion of the Mysore geologists as to the origin of these banded iron-ores regards the ferruginous amphibolites as the parent rocks, as will be seen from the following extract:—

‘This year, the few isolated outcrops of magnetite-quartzites found in conjunction with the hornblende-schist inliers in the gneiss at Dodgudda (etc.)... have yielded specimens showing gradations in the formation of these from an amphibolite. This goes to prove that the ferruginous amphibolite (cummingtonite-schist) is the parent rock which has given rise to the iron-ores in the region.’³

In another paper the same author has stated :

‘Mention has been made that the magnetite-quartzites of this schist branch are derived from the alteration of riebeckite and cummingtonite schists..... The thin quartz layers of the rock appear to me to be partly secondary enrichment in the schists at the expense of the cummingtonite and partly the result of intrusion in the schists of several thin quartz veins’⁴..... ‘the quartz bands are mainly intrusive in character and it is quite probable that a certain amount of “lit-par-lit” injection of the quartz veins in the ferruginous amphibolites and the residual clays might have taken place, with the result that a thorough and regular banding of the quartz with the different constituents of the iron-ores has been effected by subsequent pressure acting upon the whole mass of schists.’⁵

From what I have seen of these Mysore iron-ores, the hypothesis advanced by the Mysore Geological Department does not seem to be warranted by the facts. There are masses of rock which are not directly associated with amphibole-schists, and which show the fine banding similar to that seen in the iron-ore series. The explanation that the very thin and regular bands of quartz represent *lit-par-lit* injections seems also a little forced. In a recent note, Messrs. C. S. Pichamuthu and

¹ *Mem. Geol. Surv. Ind.*, XII, pp. 38–54, (1876); XXV, (1895).

² *Rec. Geol. Surv. Ind.*, XXXIV, pp. 96–131, (1906).

³ P. Sampat Iyengar: *Rec. Mysore Geol. Dept.*, X, p. 53, (1909)

⁴ *Rec. Mysore Geol. Dep.*, IX, p. 73, (1908).

⁵ *Ibid.*, p. 76.

M. R. Srinivasa Rao¹ have also cast doubts on the hypothesis, and thus came into line with the idea that the banded ores represent metamorphosed sediments. They argue that since the magnesian content of the cummingtonite and bababudanite has left no trace in the iron-ores, the explanation that these amphiboles were the parents of the ore is untenable. They also state that the amphiboles are seen only at and near the contact of intrusive traps, and have generally no parallelism with the banding of the magnetite-quartzite.

It would therefore seem more natural to regard the iron-ore-quartzites as original sediments similar to those in Bihar and Orissa and other parts of the world though the effects of the intrusion of traps and of regional metamorphism have obscured their true nature to some extent.

The presence of much magnetite (a good deal of which is, however, martite) is also to be explained as due to the effects of metamorphism. This mineral may be produced partly by igneous intrusions and partly by regional folding. The change from magnetite to martite (the latter being merely hæmatite with the external appearance of magnetite) is accompanied by an increase in volume of 5.2 per cent.² Hence, when the strata in which magnetite has been formed are relieved of the high pressure and brought up to shallow depths, a gradual change takes place, marked by the conversion of magnetite to martite. The change would be more thorough in the fine-grained rocks than in those which are massive, coarse-grained, and compact.

I have put before you my views on some of the complicated problems of the Archæans. Most of our present hypotheses and generalizations are yet no more than guesses, and await further investigation. I am confident that these and other problems will receive their due share of attention from workers in this field of geology, with the incentive and opportunities for discussions and exchange of views afforded by these annual meetings.

¹ Amphiboles in the Bababudan iron-ores. *Current Science*, I, pp. 276-277, (1933).

² J. W. Gruner: Magnetite-Martite-Hæmatite. *Econ. Geol.*, XXI, pp. 386-392, (1926).

Section of Geology.

Abstract.

GENERAL.

1. Aerial reconnaissance.

P. EVANS, Digboi.

Although the aeroplane is useful for transporting the geologist to his work and for the production of a map by photography, the discussion is concerned with the application of the aeroplane to visual reconnaissance. The importance of the 'bird's eye' view is generally appreciated and the aeroplane offers a means of getting a 'bird's eye' view from any desired point. In geological work on the ground, the methods employed will depend on many different factors, and similarly there is no universally applicable way in which aerial reconnaissance can be carried out.

At first the geologist finds the view from a plane very strange and success in interpreting what is seen depends very largely on co-ordinating air observations with ground work.

The difficulties are largely due to the unusualness of a vertical view. This is illustrated by several lantern slides. The oblique photograph from a plane has a much less unfamiliar appearance and is more easily interpreted. Stereoscopic pairs seen through stereoscope are essential to the interpretation of vertical photographs.

The height at which the reconnaissance is made is a compromise between high flying for a broad view and small altitude to get an oblique view. The speed of movement makes it necessary to record observations quickly.

A brief reference is made to the different objectives, and to the arrangements for planning a flight; methods of keeping position on the map are discussed somewhat fully.

In discussing what to look for, the Chittagong-Akyab neighbourhood is taken as an example. The three major rock groups of this neighbourhood are readily recognizable from the air by their topographical expression. Faults are sometimes very clearly seen.

A reference is made to the difficulties and limitations of reconnaissance from an aeroplane, and different types of country are contrasted.

2. Ancient gold mining and metallurgy in the Raichur district, Deccan.

CAPT. L. MUNN, Lingsugur.

Several gold mines in the Raichur district have been re-opened recently. The mines have sometimes gone down to depths of over 300 ft., and from the primitive nature of the appliances used, it is certain that the mining must have been carried on by slave labour. Regular sampling has proved that the best portions of the lodes have been worked out, leaving ledges of only lean ore. From the similarity of crushing appliances (e.g., stone mortars and boulders etc.,) found here with those in Rhodesia, there is little doubt that in those days there was communication between the two countries. Details of the mines and methods were given, fully illustrated by slides.

3. The evidence for a nappe in the Archæan (Sausar series) near Deolapar, Nagpur district.

W. D. WEST, Calcutta.

During the past 15 years Dr. L. L. Fermor and his party in the Central Provinces have mapped the Sausar series in great detail, subdividing it into a number of stages. This succession has been found to be constant over a fairly large area, and the determination of the geological structure from the distribution of these stages is therefore likely to be well founded. In this paper evidence is brought forward to show that around Deolapar, in the Ramtek tahsil of the Nagpur district, there occurs a sharp discordance in the succession, at which position one or more stages of the Sausar series are missing. The trace of the discordance is an irregular closed line, and it is clearly not a simple thrust. The details of the structure suggest that we have here a recumbent fold resting upon the surrounding rocks, from which it is separated by the discordance. Both the recumbent fold and the 'slide' upon which it rests have been further folded into a syncline.

Additional support for this view is provided by a study of the lithology. The Bichua stage, of which the recumbent fold is mainly composed, is rather different lithologically from the Bichua stage found in the adjacent rocks beyond the slide. The change of facies is too sudden to have been due to local variation in the sedimentation. But, taken in conjunction with the evidence for a slide, the difference is easily explained. It seems clear that the two sets of rocks (within and without the slide) were far separated at the time of their deposition, and have since been brought into juxtaposition with one another by horizontal movement along the slide.

4. Palæoclimates in Northern India.

J. B. AUDEN, Calcutta.

Certain features relating to palæoclimates in Northern India are brought forward. These are:—

- (1) Arid or semi-arid conditions of climate probably attended the deposition of the following series:—

Peninsula; Vindhyan and Panchet.

Salt Range; Cambrian.

Himalaya; Mandhali and Nagthar stages of Jaunsar series; Upper stage of Tal series.

- (2) The existence of glacial beds or tillites in the Talchirs of the Peninsula, in the Tanakki boulder-bed of Hazara, and in the probably equivalent Blaini boulder-bed of the Simla-Mussoorie Hills.
- (3) The existence of wind-rounded sands in the Krol sandstone of the Simla Hills.
- (4) The existence of gypsum and anhydrite in the Krol limestone of the Simla-Mussoorie Hills.
- (5) The general absence of fossils from the pre-Tertiary rocks of the outer Himalaya; their abundance in the rocks of the Tethys zone to the north.

The Himalaya may be divided into Peninsular Himalaya and Tethys Himalaya. Among the rocks present in the Peninsular Himalaya which bear direct relationship to those in Peninsular India may be cited the Gondwanas of the Eastern Himalaya in North Bengal and Assam, the Blaini boulder-bed of the Simla-Mussoorie Hills, the Gondwanas of Kashmir and the Tanakki boulder-bed of Hazara. Representatives of the

Vindhyan may perhaps be found in the cystid-bearing limestones and associated phyllites and quartzites of the Chandragiri range in Nepal. The broad climatic changes, witnessed both in Peninsular India and in the Peninsular Himalaya, were:—arid conditions in the early Palæozoic; glacial conditions in the late Palæozoic; arid or continental conditions in the Mesozoic. The inversion temperatures of gypsum into anhydrite are discussed in relation to temperatures which may have prevailed during the deposition of the Krol limestone. Stringent conditions may have been partly responsible for the general absence of fossils from the rocks in the Peninsular Himalaya.

5. Caves in the Bhuban Hills, Cachar District, Assam.

P. EVANS and B. H. SINGH, Digboi.

The Bhuban Hills ($24^{\circ} 40' : 93^{\circ} 0'$) south-east of Silchar, provide good sections in the rocks of the Surma Series and have given their name to the Bhuban Stage of these beds. The hills attain a height of over 3,000 feet and the western face includes imposing cliffs of sandstones in the Upper Bhuban Sub-stage.

In a part of the hills where the arenaceous Upper Bhuban beds dip south-eastwards at low angles, there are two long narrow caves. A complete exploration of the caves has not been made, owing to difficulties of progress in their more remote parts. The paper gives a plan, sections, and photographs of the caves made during a survey of the accessible parts in December, 1933.

The caves occur in sandstone beds containing very little calcareous material and are strikingly unlike the caves found in limestone country. The total length of the two caves is over 1,600 feet; they lie on approximately the same line and trend in a direction S. 15° E. The hills strike in a direction almost due south, appreciably different from the trend of the caves. Although the caves contain recent human remains, they are not artificial, and appear to be due to the enlargement of joints in the sandstone.

STRATIGRAPHY AND PALÆONTOLOGY.

6. The Saline Series of North-Western India.

E. R. GEE, Calcutta, with an appendix on the Heavy Minerals by P. EVANS, and M. A. MAJEED, Digboi. *

On stratigraphical grounds and from the evidence of included Dicotyledonous leaves, it is concluded that the Saline series of the Salt Range is Lower Eocene in age and is homotaxial with the similar deposits of the Kohat area.

In order to explain the tectonics, the writer postulates two periods of earth-movement, namely, a late Eocene-Oligocene period during which the older strata of the Salt Range were brought south-wards across the Saline series of that area; and secondly, a late Tertiary-Sub-Recent period of complicated thrusting and folding.

An Eocene age for the Saline series is supported by the evidence of its heavy mineral content which closely resembles that of the Eocene limestones and shales and is distinct from the heavy mineral suite of the Mesozoic and Palæozoic strata of the Salt Range.

7. Geology of the country in the vicinity of Bagh.

M. P. BAJPAI, Benares.

W. T. Blandford, in his memoir on Western India, mentions that a peculiar triangular tract near Bagh is occupied by the Bijawar Series.

This tract has been sub-divided into shales and slates, dolomitic limestones, carbonaceous shales, black marble, conglomerate and Deccan Trap, and has been mapped on a scale of 1" to 1 mile by the present author. The bedding planes in the area are extremely obscure and the rocks have been highly cleaved, folded, and faulted. The greenstones which occur associated with shales and slates and the dolomitic limestones have been studied chemically and petrographically. The correlation of these Narbada valley rocks with the Bijawar and Delhi series is also discussed.

8. Some Local phases of Regional Metamorphism of Dharwars in the eastern portion of the Raichur Doab.

S. K. MUKERJEE and C. MAHADEVAN, Lingsugur.

During the mapping of the eastern portion of the Raichur Doab (between Lat. $15^{\circ} 55'$ and $16^{\circ} 30'$, Long. $76^{\circ} 55'$ to $77^{\circ} 35'$) a band of Dharwar schists, not hitherto reported, has been traced, extending right across the Doab in a N.N.W. direction from the Tungabhadra to the Krishna river.

In this band, besides the normal hornblende and chlorite schists, (1) fine-grained diabasic, (2) granulated medium to coarse-grained, and (3) fine-grained siliceous, types could be recognized.

Structural and field relationships suggest that this band of Dharwar rocks has been subjected to great regional metamorphism.

The paper sets forth the results of the study of this band.

9. On the age and correlation of the plant beds in the Trichinopoly District.

C. PRASANNAKUMAR, Bangalore.

The existence of plant beds below the marine cretaceous rocks of the Trichinopoly District has been known from a long time. A review of the literature connected with these rocks shows that there has been no unanimity or preciseness in the age assigned to these beds and these have been merely mentioned as part of the Upper Gondwanas. During the course of a few recent visits the different exposures of these plant beds have been examined in detail, and the present paper embodies the results of these observations. The evidence gathered both in the field and from the fossil plants goes to show that these are best regarded as not much older than Lower Cretaceous (Wealden).

10. Notes on the Geology of Lower Cuddapah—II.

C. PRASANNAKUMAR and M. R. SRINIVASA RAO,
Bangalore.

In a previous communication to this section of the congress in 1934, the authors have given a general account of the occurrence and stratigraphical distribution of the igneous rocks associated with Lower Cuddapah sediments. The present paper embodies the results of an intensive petrographic study of a portion of these igneous rocks (those belonging to Papagni Series) and their associates. Several interesting metamorphic effects accompanying this igneous activity have been described in detail and an attempt has been made to fix the grade and facies of this metamorphism.

11. An acaulescent fossil palm from Chhindwara District, C.P.

K. P. RODE, Benares.

This peculiar corn-like fossil plant specimen was obtained by the author during May, 1934, from Umaria, about 10 miles east of Chhindwara.

in the Central Provinces. This new plant-bearing locality is only 10 miles west of Mohgaon Kalan from where the author made a large collection of Intertrappean Flora during the last four years. The specimen, which is the only one so far discovered in this area, was not found *in situ*, but from the nature of its matrix, it can safely be taken as belonging to one of the Intertrappean bands outcropping in this locality.

In its external form the specimen is hemispherical with a roughly plane base and is traversed by several longitudinal depressions on the upper surface where the somewhat badly preserved internal tissues have been exposed. The transverse section, however, clearly shows under the microscope the typical palm structure, thereby enabling easy correlation with the fossil composite genus *Palmoxylo* Schenk. A close study of the structure as well as the form points to its being a new species and this has been named *P. umariensis*, after the locality.

12. On a dicotyledonous leaf impression: *Phyllites mohgaonensis*, sp. nov., from the Deccan Intertrappean Beds of Chhindwara District, C.P.

K. P. RODE, Benares.

The Intertrappean beds of Mohgaon Kalan, District Chhindwara, C.P., have yielded several leaf impressions of angiosperms. The author has described one of the dicotyledonous species from this collection.

The impression consists mainly of the top portion of originally a fair-sized leaf, roughly ovate in form with entire or undulate margin and obtuse apex. The venation is of the pinnate, net-veined type, with a stout straight mid-rib, and numerous secondaries and tertiaries. It compares closely with *Diospyros* and *Ficus* but its affinities are uncertain due to incomplete preservation.

Age:—Upper Cretaceous Intertrappean.

13. On the occurrence of a new Loxodontine form of Elephant in the Indian Cainozoic: *Palaeoloxodon priscus* var. *bosei*.

D. K. CHAKRAVARTI, Benares.

Prof. Bose of Jammu, in a notice of some mammalian remains from the Siwaliks of Jammu, gives the figure of a part of a molar (R.I. 806) which appears to the present author to bear a very strong resemblance to a molar (No. 39370, British Museum) of *Elephas (Loxodon) priscus* represented in fig. 7 of Plate XIV of the *Fauna Antiqua Sivalensis*. This latter form, established by Goldfuss in 1821 on some scanty material from England, was recognized by Falconer for a long time as a distinct species closely allied to the living African Elephant, but was later regarded by him as a form of *E. antiquus*. After comparing the Jammu form with *E. priscus*, *Palaeoloxodon antiquus*, *Archidiskodon planifrons*, *Loxodonta africana*, and *Stegodon bombifrons* (to which Bose has referred the molar in question), the present author finds reasons to regard it as a variety of *E. priscus* Goldfuss.

14. On the generic reference of a doubtful Rhynchorostrine Bunomastodontid from Chinji in the Salt Range.

D. K. CHAKRAVARTI, Benares.

A left mandibular ramus (Amer. Mus., No. 19415) collected by Barnum Brown from near Chinji has been referred by Osborn to the genus *Rhynchotherium* on the basis of its apparently downturned rostrum. In the preserved portion of the specimen there is no evidence of downturning of the symphysis. The rostrum appears to be downturned, but

it is evidently in an imperfect condition of preservation. The warping of the alveolus of the tusk appears to the present author to be a case of distortion superinduced upon the specimen after its entombment. This is corroborated by the nature of M_2 , the grinding surface of which lies at a much lower level than that of the adjoining tooth, M_3 . Hence there is no ground for referring this specimen to *Rhynchotherium*, a form confined to the south-western part of N. America. The author suggests that it should be referred to *Trilophodon angustidens* (Cuvier) var. *chinjiensis* (a name proposed by Pilgrim in 1913 for a form discovered in the Salt Range but not described as yet).

15. A new intermediate stage in the evolution of Indian Stegodon species : *Stegodon elephantoides* (clift).

D. K. CHAKRAVARTI, Benares.

A new stage in the evolution of Indian Stegodons is represented by a lower molar (Plate XXXVII, fig. 2, *Trans. Geol. Soc.*, 2nd Ser., Vol. II) collected by Crawford from Burma and described by Clift under *Mastodon elephantoides*. This was later referred to *Stegodon insignis* by Falconer, who appears to have overlooked the differences between the characters of the specimen concerned and those of the type molar of *S. insignis*. The remaining part of the material under *M. elephantoides* was separated and assigned to *S. clifti*.

The author traces the affinity of this type from Burma with the type molars of *S. orientalis* Owen, *S. insignis birmanicus* Osborn, and a few others—all of which should be referred to the Burma form in consideration of its priority.

16. A note on the recent shore sands at Neendakara near Quilon.

K. Y. SRINIVASA IYENGAR, Bangalore.

The paper gives an account of the analysis of a sample of recent shore sands obtained at Neendakara near Quilon with special reference to the mineral and faunal assemblage therein. The general composition of the sand is as follows :—

Quartz	61.6%
Calcareous matter	16.6%
Clayey matter	5.89%
Heavy residue	15.8%

Nearly 90% of the heavy residue is ilmenite, the rest being made up by zircon, monazite, and garnet.

Of the microzoa, the foraminifera are the most abundant—the most common forms being *Rotalia*, *Nonion*, *Triloculina*, *Spiroloculina*, *Elphidium*, etc.

17. Supplement to a Monograph of the Terebratulidæ of the British Chalk.

M. R. SAHNI, Calcutta.

The author has recently examined 335 Terebratulids collected zonally from the British Chalk, which collection was entrusted to him by the British Museum (Natural History) for investigation. With few exceptions, all the Terebratulids investigated fall under the subfamily *GRYPHINÆ* Sahni. For the reception of certain genera, with divided inner hinge-plates, like *Terebratula* Muller s. str., *Neolithothyrina* Sahni,

Rectithyris Sahni, a new subfamily of the Terebratulidæ is proposed to be established. The author claims that he has established a satisfactory basis of classification for the Upper Cretaceous Terebratulid species, and that the same classification can be extended to separate stocks of Jurassic and Tertiary age.

MINERALOGY AND PETROLOGY.

18. A quartz-garnet intergrowth with the outer form of garnet.

A. K. ROY, Calcutta.

The specimen is a portion of a fairly big crystal of garnet and measured $4'' \times 4'' \times 3''$. It was obtained from a pegmatite dyke, north of Gujandi, Gaya District.

Although it exhibits the characteristic form of garnet, the interior has an excellent graphic intergrowth of garnet and quartz. The approximate ratio between garnet and quartz, as calculated from the specific gravities, is 73 : 27. The graphic intergrowth appears to be due to eutectic crystallization.

19. 'Blue Amphiboles' from Mysore.

P. R. JAGAPATHY NAIDU, Bangalore.

Frequent reference has been made in the Records of the Mysore Geological Department to the occurrence of 'Blue Amphiboles' in various kinds of rocks in Mysore. These blue amphiboles have now been studied by the author and it has been shown that they vary from actinolite through basaltic hornblende to glaucophane, with an appropriate mineral suite of metamorphic origin like garnet, deep brown biotite and epidote. The exact mode of origin of these blue amphiboles is also different in different places.

20. Petrological notes on some of the rock types of Kalmali, Kallur, Nilagal, and Ganekal hills, Raichur District.

L. S. KRISHNAMURTHY, Lingsugur.

In the Dharwar band described by Mukerjee and Mahadevan, some prominent hills occur near Kalmali (Lat. $16^{\circ} 11' 52''$, Long. $77^{\circ} 12' 50''$), Kallur (Lat. $16^{\circ} 8' 29''$, Long. $77^{\circ} 11' 49''$), Nilagal (Lat. $16^{\circ} 11' 52''$, Long. $77^{\circ} 8' 0''$), and Ganekal (Lat. $16^{\circ} 14' 0''$, Long. $77^{\circ} 7' 3''$).

These hills consist of rock types with granulitic structure, containing apatite, pyroxene, micas, and other ferromagnesian minerals and sometimes blue blebs of quartz. The paper describes the petrological characters of the representative types.

From magascopic and microscopic characters, the affinity of these to the so-called 'pseudo or quasi-Charnockites' described by the Mysore Geologists is discussed.

21. Porphyritic dykes in parts of Raichur and Manvi Taluqs.

C. MAHADEVAN, Lingsugur.

In the southern parts of Manvi and Raichur Taluqs, Raichur Doab, a large number of dykes have been traced with a N.W. to S.E. trend, most of them being very long. They occur near the junction between the Dharwar schists and the gneisses of the crystalline complex.

One of these dykes which is normally doleritic in character, shows porphyritic feldspars and quartz, for a distance of about 6 miles. To the south of this, another dyke which is also normally doleritic, becomes locally siliceous and for a distance of about 3 miles includes xenoliths of gneisses and vein quartz.

The paper discusses the field relationship, structural peculiarities, and microscopic characters of these two abnormal members of this group of dykes.

22. Dyke rocks of Gudwal Samasthan, Raichur District.

H. S. KRISHNAMURTHY and L. S. KRISHNAMURTHY,
Lingsugur.

Numerous dykes, mostly of doleritic nature, are found traversing in a W.N.W.-E.S.E., and rarely also in a N.-S. direction. They are of post-gneissic age, but there is no stratigraphic evidence in this area to define their upper limit.

The paper discusses their mode of occurrence, age, and petrological characters.

23. A note on the Arakere granite (Mysore).

B. N. RAGHUNATHA RAO, Bangalore.

The paper deals with a detailed study of the small east-west granitic hills near Arakere, a small village in Mandya Taluk. This granite is distinctly intrusive into the gneisses, hornblende schists, and quartzites which form the country rock; and the intrusion appears to be of the laccolithic type. On a careful examination, three distinct facies of the granite have been distinguished: (1) the pale pink to grey coloured normal granite, (2) the graphic granite with a deep pink colour, and (3) the hornblende grey diorite-like rock, the last one showing evidences of contamination. The relation of this granite to the felsite and porphyry dykes extensively found in this area has also been discussed.

24. Petrography of some gneisses and associated basic rocks of the Santal Parganas, Bihar.

S. K. RAY, Calcutta.

The paper contains a preliminary petrographical account of some rocks which occupy the country extending north and south between Deoghar and Jasidih in the Santal Parganas, Bihar.

The rocks fall into two broad groups, one acid and the other basic. The acid group includes foliated biotite-hornblende-gneisses and hornblende-pyroxene-bearing granulitic rocks, together with quartz-felspar rich types of aplitic, pegmatitic, and sub-pegmatitic nature. There are local augen and porphyritic felspar-bearing variants of the gneisses. The pegmatitic bodies cross all the above rocks (and some rocks of the basic group) in the form of dykes or less regular patches. The mutual relationship of the gneisses, the granulites, and the quartz-felspar-rich types is not clear; the pegmatitic bodies are occasionally seen to pass into them with imperceptible gradation.

The basic group comprises amphibolites and other melanocratic rocks which are composed of hornblende, monoclinic and rhombic pyroxene, biotite and plagioclase. They occur within the acid suite as clean-cut bands of variable shapes and dimensions, and as larger and more irregular dyke-bodies or domes. Isolated fragments of faulted basic bands and xenoliths of some basic rocks are also found, and morphological variations and peculiarities presented by the former form the most conspicuous feature of this interesting area.

25. Petrological classification of the Dome Gneiss of Kodarma.

S. K. ROY and N. C. NANDY, Dhanbad.

During a detailed survey of the area (Scale 4"=1 mile) four Dome-gneiss hills, viz., the Dangru, the Dhajadhari, the Surangi, and the Nero, were mapped near Kodarma.

Presence of enclaves, disappearance of some older beds which are supposed to have been lifted up by the dome-gneiss and subsequently weathered away, and the mode of occurrence of the rock in the field establish the intrusive batholythic nature of the dome-gneiss, whose age is post-Dharwar.

The dome-gneiss can be classified according to texture, colour and mineral composition. The main group is devoid of epidote and can be sub-divided into pink biotite-gneisses and grey hornblende-gneisses. Helvite, an isotropic Be-Mn-Fe silicate, has been discovered as a constant associate of both these varieties. The pink colouration is due to the presence of haematite and limonite in powdery form, along the cleavages of the potash feldspars. The subordinate group is an epidote-gneiss which may be the alteration product of a basic (gabroid) differentiate of the main group.

Both enclaves pneumatogènes and enallogènes have been observed. These include Epidote-feldspar-anatase-tourmaline rock, Epidote-tourmaline rock, Tourmaline-muscovite-feldspar rock, which are examples of enclaves pneumatogènes; and Biotite-gneiss and Amphibolite which are enclaves enallogènes.

The average joint directions of Dome gneiss, as has been determined by means of Kloos' cleavage-rose are E.S.E.-W.N.W., and N.E.-S.W. which coincide with the chief strikes of the mica-pegmatites of the area.

26. Geology and petrology of the Mica Pegmatite of Kodarma.

S. K. ROY, N. C. NANDY, and N. PRASAD, Dhanbad.

A systematic study of the mica-bearing area around Kodarma revealed the presence of amphibolite, pyroxene-granulite, norite and pyroxenite in addition to the dome-gneisses, mica and other schists and pegmatites whose presence has already been recorded. The usual directions of the joints (Kloos) are N.N.W.-S.S.E. and N.N.E.-S.S.W., and their directions of schistosity W.N.W.-E.S.E. and E.N.E.-W.S.W.

The pegmatites can be classified according to age and mineral composition into (1) later post-Dharwar pegmatites rich in microcline and devoid of mica of economic value, generally traversing the dome-gneiss and sometimes the schists, (2) pegmatites of middle post-Dharwar age with little or no microcline, but with plagioclase and valuable books of mica, traversing the schists and (3) pygmatic veins of early post-Dharwar age. The pegmatites mark the close of the period of post-Dharwar intrusions.

The minor rock-groups found in the area include normal amphibolite, zoisite-amphibolite and garnet-amphibolite; pyroxene-granulite and garnet-granulite; biotite-norite, hornblende-augite-norite and olivine-norite.

27. The heavy minerals of the Erinpura Granites and Microgranites of Danta State, Gujerat.

N. L. SHARMA and S. PURKAYASTHA, Dhanbad.

The paper gives the results of examination of 26 heavy mineral slides prepared from fairly representative specimens of the rocks collected from the Danta state. The percentage weight of the various

specimens of granite and microgranite exceeding bromform in density ("index" figure) and the frequency of the heavy minerals in them has been determined. The common heavy minerals of the granite and microgranite are zircon, sphene, fluorite, epidote, zoisite and magnetite or ilmenite. In the granites, biotite and hornblende are very abundant. Muscovite, tourmaline, chlorite and rutile are also found in some slides: but the most interesting minerals observed in some of these slides, though rare, are axinite, monazite, kyanite, glaucophane and thulite. A brief description of the important heavy minerals, with sketches, are given in the paper.

28. The Raniganj anorthosite.

S. C. CHATTERJEE, Patna.

The Raniganj anorthosite covers an area of approximately 100 sq. miles and extends across the southern part of the Raniganj coal-field in the districts of Bankura and Manbhum. In the latter district it shews definite intrusive relation to the Archæan complex.

There are associated granite and norite dykes and contemporaneous veins, and all the three rocks anorthosite, norite, and granite—belong to the same Petrographical province.

The structural relations of the three chief rock types are discussed in relation to their bearing on the mode of origin of the anorthosite body. Results of chemical and microscopic studies are also indicated.

29. On the occurrence of an ultra-basic rock in the Raniganj coal-field.

N. N. CHATTERJEE, Calcutta.

In the paper the author has described one ultra-basic rock occurring in the Jamuria area of the Raniganj coal-field. The rock is found to be intrusive into the Raniganj coal-measures. The coal lying in the adjoining locality has been appreciably damaged and converted to *ghama*. One of the interesting features of the rock is the presence of patches of felspar and quartz about an inch in length. The physical and chemical characters of the rock are discussed in the paper.

30. Petrology of the Igneous Rocks of the Bijawar Series.

M. P. BAJPAI, Benares.

Geological mapping of an area, about 16 miles long and 11 miles wide in the central portion of the type area, reveals that igneous rocks are of frequent occurrence in the series. Palda, Surajpura, Sarwa, and Rampura are some of the new localities of their occurrence. The rocks are medium-grained quartz-dolerites. Late crystallization of iron-ore is shown by the inclusion of felspar and pyroxene in magnetite. Four chemical analyses show that the rocks are richer than the Deccan Traps in soda. In these two respects the Bijawar dolerites closely resemble the Gwalior Traps previously studied by the author.

31. Field description of some of the occurrences of Igneous Rocks of Cutch.

M. P. BAJPAI, Benares.

A period of about 7 months was devoted to the study of the igneous rocks of the mainland of Cutch during the field-season, 1933-34. The paper describes some of their important occurrences and structural characteristics. Petrographic and chemical description of rocks, which

have so far been studied, has also been included. The study shows that there had been two phases of igneous activity in Cutch, one basic and the other ultra-basic.

32. Preliminary study of some lava flows of the Rajmahal Hills.

N. P. KATAKI, Calcutta.

In the paper the author has described the petrographical features of the basalt flows occurring in the neighbourhood of Pratappur (Lat. $25^{\circ} 7' 43''$; Long. $87^{\circ} 22' 21''$) and Goradi (Lat. $25^{\circ} 6' 15''$, Long. $87^{\circ} 25'$). Field evidences have shown that there are seven distinct flows in the neighbourhood of Pratappur and five in the Goradi region. The microscopic examination of the basalts shows that the primary constituents include plagioclase feldspar, augite, magnetite, and glass. The secondary minerals consist of chlorophæite, chabazite, calcite, and palagonite. The rocks are porphyritic with the phenocrysts of feldspars which show sometimes zonary banding. The flows differ from one another in the coarseness of the minerals and in the amount of glass. The nature of some of the intertrappean beds is also dealt with. The author has suggested some correlation of the lava flows of these two regions.

33. On the occurrence of scoriaceous lava in the neighbourhood of Simra in the Rajmahal Hills.

N. N. CHATTERJEE, Calcutta.

The author of this paper collected several specimens of highly porous and vesicular basalt lava from Simra (Lat. $25^{\circ} 2'$; Long. $87^{\circ} 21'$) and its neighbourhood in the Rajmahal Hills. The basalt layers are found to rest on the infra-trappean bed of white shale which has been sufficiently baked due to the contact effect. Several fragments of quartz and shale are found to have been entangled in the extrusive rock. The overlying portions of this scoriaceous rock consist of coarsely granular and porphyritic basalt with augite and feldspar as the chief constituents. The feldspar phenocrysts have lamellar twinning and zonary structure. The paper deals with the physical and chemical characters of this vesicular slaggy basalt in detail and with its field relationship. An attempt has been made in the paper to correlate these with the basalt flows of the adjoining localities.

34. Some observations on the diamond-bearing rocks of Banganapalli and Wajrakarur.

K. RAJAGOPALASWAMY, Madras.

All the diamond-bearing rocks of India belong to the Vindhyan System the diamonds occurring mostly in two distinct conglomerate horizons, the upper one being productive in N. India and the lower one in S. India. The two most important diamond localities of South India are Banganapalli and Wajrakarur. At Banganapalli the diamonds occur *in situ* in the basal conglomeratic strata of the Kurnool Series. The productive layer, which is only a few inches thick, is a shaly or sandy conglomerate containing pebbles of quartzite, jasper, and shale, the heavy mineral suite revealing magnetite, ilmenite, rutile, zircon, and apatite. The diamonds seem to have been derived by weathering from certain trap-sills intrusive into the Vainpallis and the Cheyairs. An examination of these igneous rocks shows them to be composed essentially of augite and basic feldspar. A quantitative mineralogical estimation of this rock has been made and its composition calculated therefrom.

At Wajrakarur the occurrence of diamonds is rather peculiar, there being no definite diamond-bearing bed as at Banganapalli. There is, however, a remarkable volcanic neck around which diamonds are picked up regularly. This neck has only a superficial resemblance to the Kimberlites of South Africa. No diamonds have ever been found in the tuff material itself so that it is difficult to regard this neck as the source of diamonds. M. Chaper has put forward the theory that the diamonds have been derived from the pegmatite veins that penetrate the country rock. Such an idea is untenable since there are scarcely any pegmatites in and around Wajrakarur. But there are isolated outcrops of decomposed basic igneous rocks which seem to be of the same age as the trap-sills of Banganapalli and are also similar to them in mineralogical composition.

That the diamonds should occur only in the Vindhya's all over India is more than a coincidence. They are always in close proximity to granitic, gneissic, and schistose area penetrated by basic dykes of Bijawar age (the equivalents of the South Indian Cheyairs). It is therefore suggested that the basic dykes of Bijawar age are the home of Indian diamonds.

35. The occurrence of some acid and Intermediate Rock * Types in the Salsette Island, (Bombay).

A. S. KALAPESI and G. P. CONTRACTOR, BOMBAY.

In this paper, some acid and intermediate outcrops of the Deccan Trap Lavas which have not been recorded so far are described. The localities from where the specimens were collected are: (1) Santa Cruz—Khar area; (2) Kurla area; (3) Jogeshwari area and (4) Marol Hills.

In (1), rock types such as 'Rhyolite Ash' and 'Glassy Tuffs' are present. The outcrops extend as far as the neighbourhood of the Pali Hill (Bandra), and their general height above the surface is about 10 ft. Bedding is rare, which may be due to the ejection of rhyolite dust immediately after explosion. Another type exposed in this area is 'felsite' which occurs as intrusions running parallel with the coastline of the island. A third interesting type is 'perlite' which occurs as scattered boulders and blocks only.

In (2) 'Trachyte' and 'Dolerite' occur in the form of intrusions seldom higher than 10 ft. above the level of the ground; the trachyte intrusions resemble a rock type from Kharodiwadi described by Dr. Krishnan.

In (3) the ridge in which the caves are carved, is made up of weathered rock, apparently an altered granophyre.

The outcrops in (4) are 'Augite-granophyres' the intrusions being parallel to the coastline. This is the only area where augite is present in the acid rock. This rock occasionally shows flow structure.

ECONOMIC GEOLOGY.

36. On the occurrence of Mica at Gurpa, Gaya.

M. P. BAJPAI, Benares.

Pegmatitic veins rich in mica occur in the neighbourhood of Gurpa, a railway station on the East Indian Railway, about 25 miles south-east of Gaya.

Three veins running parallel to one another were traced for a length of 9 miles. The paper contains a description of Mica, the country rocks and the accessory minerals, and discusses the possibility of developing this area. The discovery of mica at Gurpa extends the Bihar Mica Belt by about 14 miles westwards.

37. The use of nepheline syenite in the glass industry in India.

V. S. DUBEY and P. N. AGARWAL, Benares.

The two deposits of nepheline syenite in Northern India are found in the Girmar Hills of Kathiawar and in the Kishengarh State in Rajputana. Pegmatoid varieties are also associated with them. So far, these rocks have been used only as road metal. Their average composition is : silica 56 per cent., alumina 20, total iron 4, soda 9, potash 5, lime 2, magnesia 1, and other constituents 3 per cent. This investigation was taken up with a view to reducing the cost of glass manufacture by substituting nepheline syenite rock as the source of soda instead of imported soda-ash. The cost of the rock containing 14 per cent. of alkalis is about 8 annas per cwt., while that of soda-ash with 58 per cent. of the same is about Rs. 7 per cwt. Thus, for getting the same amount of alkalis out of the rock, the cost will be only about Rs. 2.

Glass of the following batch composition—sand 100 parts, rock 100 parts, lime 25 parts, and sodium carbonate 25 parts—has been found to be satisfactory and can be melted at 1,250°C. and easily blown. The iron-free pegmatite gives an almost white glass, while the ordinary rock gives a bottle-green glass because of its containing ferro-magnesian minerals. The removal of such minerals from similar rocks has been accomplished in Russia, and attempts are being made to evolve a process here. The success of such a process will make billions of tons of this rock available for glass manufacture in this country.

Alumina imparts several good properties to the glass, such as lustre, resistance to chemical action and mechanical shocks, reduction of the tendency to devitrification and better annealing properties. It has been found that the introduction of alkali through the nepheline syenite rock gives a glass which is less viscous than that got by using orthoclase feldspar.

38. Occurrence of Bauxite in the Thana District, Bombay.

M. S. PATEL, Bombay.

Dr. Fox has stated in his monograph on bauxite that there is possibility of finding aluminous laterite beyond Bassein Creek, on Kamandurg hill and on the tableland of Tungar in the Thana District of the Bombay Presidency. The area has been investigated. High grade bauxite has been found on the Tungar hill. Bauxite occurs on the scarps of the Tungar plateau in the form of boulders about 10 to 15 feet from the top under an overburden of ferruginous laterite. The analysis of the samples is as under :—

	A	B	C	D	E
SiO ₂	9.66	4.25	2.75	0.62	1.02
TiO ₂	4.15	4.02	1.84	4.68	6.21
Al ₂ O ₃	47.95	54.42	52.99	57.08	55.14
Fe ₂ O ₃	3.95	7.87	13.49	5.00	5.11
MgO	1.49	trace	trace	trace	trace
CaO	trace	trace	trace	trace	trace
Loss on ignition ..	32.78	29.35	29.88	32.2	32.63
TOTAL	99.98	99.91	101.05	99.58	100.11
Sp. Gr.	2.4	2.22	2.3	2.29	2.16

The investigation that has been done so far indicates that there is a possibility of finding an adequate deposit of bauxite for the manufacture of aluminium. A navigable creek is found about 3 miles from the deposits and so it will be possible to transport the mineral in barges to Bombay or Kalyan, a distance of about 60 miles. The cost of transport from the wharf on the creek to Bombay or Kalyan is likely to work out at Rs. 0.7 per ton. A firm in Bombay has applied for prospecting licence.

39. Occurrence of natural gas in Broach District, Bombay.

M. S. PATEL, Bombay.

From the casual geological observations made by the author in connection with his investigation work regarding the occurrence of natural gas at Gogha, Ahmedabad District, Bombay, he found that there was a possibility of the gas field extending on the other side of the Gulf of Cambay round about Broach. The area has been investigated and natural gas has been located in a *kund* at Hajad, a village in the Ankleshwar Taluka of the Broach District. The gas has been found to contain about 94% combustible gases calculated as methane. If found in adequate quantities the gas will be a very cheap source of power and heat to the adjoining industrial centres of Broach, Ankleshwar, and Surat. A firm in Bombay has been granted prospecting licence.

40. A note on the bore-hole logs in parts of Aurangabad and Parbhani Districts discussed in relation to the distribution of underground water in the Deccan Traps.

C. MAHADEVAN, Lingsugur.

The conclusions arrived at by Capt. Leonard Munn regarding the distribution of underground water in Deccan Traps (*Journal, Hyderabad Geological Survey*, Vol. II, pp. 89-102) were further verified from the examination of the bore-hole records maintained by the Agricultural Department of H.E.H. the Nizam's Government and by actually visiting the sites of the wells in Aurangabad and Parbhani Districts of the Hyderabad State. The paper describes the results of this study.

41. Action of certain solvents on some Indian vitrains.

N. N. CHATTERJEE, Calcutta.

The author has carried out in the laboratory some experiments on the action of pyridine and chloroform on some Indian vitrains. The specimens include (1) Vitrain from Korea State coal; (2) Vitrain from Kargali seam, Bokaro coal-field; (3) Vitrain from South Karanpura coal. The specimens are all of Barakar age. Several specimens of Tertiary vitrains obtained from Watching and Tipongpani coals, Upper Assam, and from Namma and Kalewa coals, Burma, were also subjected to the solvent action of pyridine and chloroform. The alpha, beta, and gamma compounds have been determined quantitatively in all these specimens and the relationship between these extracts and the caking and swelling properties has been discussed in the paper.

42. A short note on the sulphur compounds in some of the coal specimens from Upper Assam.

N. N. CHATTERJEE, Calcutta.

In a previous communication the author described the high grade Tertiary coals of Upper Assam and recorded the occurrences of different

sulphur forms in them. The present paper embodies the result of further study in that direction and includes Watching, Tipongpani, and Namdang coals which are all of Eocene age. The distribution of the sulphide, sulphate and organic forms of sulphur in the specimens of coal before and after high temperature carbonization has been discussed in the paper.

Section of Botany.

President:—DR. J. H. MITTER, M.A., B.Sc., Ph.D.

Presidential Address.

FUNGOUS PLANT PATHOLOGY AND MYCOLOGY IN INDIA.

Historical.

While the Phanerogams of India were known to a very fair extent before the end of the nineteenth century, the fungi were only collected here and there by the early explorers and Botanists who visited the country. The reason for this has, I dare say, been the smallness of their size and the belated interest in them. I recall amused a remark which fell from the lips of a young Mycologist in India several years ago. As happens so frequently in this land of mistakes, power had preceded knowledge and the young officer, too raw as yet to realize the importance of his vocation, said to an assistant who was trying to impress him with the necessity of a padlock for a herbarium cabinet, 'No one is going to steal all that rubbish'. The Mycologist was not far wrong, but the trouble is that this rubbish has to be reckoned with, since fungi take a heavy toll of our crops and add to the misery of the starving millions in India.

It is interesting to find that probably the first Indian fungus of which we have a definite record was collected nearly 165 years ago by Koenig, a Danish missionary in Tanjore and described by the famous Botanist Linnaeus as *Lycoperdon pistillare*, later changed to the genus *Podaxon*. Fries examined fungus collections made by Koenig as well as those made by one Didrick Ferdinand Didrichsen in the Nicobar islands when he was there in the course of a trip around the world in 1845-1847. A number of Indian fungi were collected by Wight early in the 19th century. Montagne recorded a few fungi collected by Belanger from 1825 to 1829 and also those found by Perrottet who came out to India about 1840 and made collections chiefly in the Nilghiri hills. Corda and others also mention specimens which travelled across to Europe from India but the total number of Indian species recorded before 1850 were probably not more than a hundred.

Sir Joseph Hooker and, to a lesser extent, his co-worker Dr. Thompson collected hundreds of fungi in 1849 and 1850 chiefly from Sikkim or elsewhere in the Himalayas and from the Khasi hills. These collections were described by Berkeley who began their publication in 1850. Many of the specimens of this collection were fleshy gill fungi which led Berkeley to suppose

and remark 'The Agarics seem to form by far the greater portion of the fungi of the country'. In spite of the very difficult task Berkeley must have had in comparing these dried agarics and Hooker's drawings of them with previously described species, even now, 84 years after his labours, most of the Agaricaceæ in India can be known only from the specimens Berkeley examined. Sulpis Kurz, Curator of the Royal Botanic Garden, Calcutta, collected several fungi in Bengal and made the first extensive collection of Burmese fungi. Currey published an account of these specimens in 1874. About this time and for some years following Cooke at Kew was describing large numbers of Indian fungi. Specimens were also being sent abroad to other well-known Mycologists such as Rabenhorst, Brefeld, Patouillard, Dietel and others. At the close of the 19th century collections were made by Gollan in the United Provinces and studied by P. Hennings. George Massee now started the series 'Fungi Exotici' in the Kew Bulletin which was carried on by him and Miss Wakefield for a number of years. A collection of Bombay fungi was made by Rev. E. Blatter and described by Rev. P. Theissen. A few Indian fungi were also examined by Bressadola and Saccardo. The American Mycologist, C G. Lloyd, appears to have studied several of the larger Indian fungi. In the neighbouring colony of Ceylon, the Government Botanist T. Petch made a very valuable contribution to its Mycology. His work on entomogenous fungi and those reared by termites is of special interest and not without its use to India.

All this work deals with the study of fungus specimens collected in India and sent abroad for identification to the herbaria in Europe or America. In the meantime work was begun in India itself and two members of the I.M.S., D. D. Cunningham and A. Barclay were the pioneers in this field. Cunningham published between 1875 and 1897 the results of his studies on certain Indian fungi, especially Mucoraceæ and Uredinales, collected in Calcutta and other parts of eastern India.

About 1885 Barclay began his critical work on the rusts near Simla and in a remarkable series of papers published in the Scientific Memoirs by Medical officers of the Indian Army and elsewhere, he contributed not only to a knowledge of the Uredinaceæ of India but to the biology of this group as a whole. After Barclay's death Sir George Watt also made collections of and observations on a few fungi parasitic on tea and some other crops.

This brings us to the advent in India in 1901 of Dr. E. J. Butler, then M.B., F.L.S., now D.Sc., F.R.S., C.I.E., who will always be remembered with respect as the real father of Mycology and Plant Pathology in India and to whom our country owes a deep debt of gratitude. I remember a Mycologist in London waxing enthusiastic and saying 'I consider Butler to be the greatest Mycologist in the world'.

The Imperial Research Institute, Pusa.

Butler arrived in Calcutta in 1901 and was transferred to Dehra Dun as Cryptogamic Botanist to the Government of India, a designation which he later had appropriately changed to that of Imperial Mycologist. It was not till November, 1905, that he commenced his work at Pusa in the Imperial Agricultural Research Institute. Provided with assistants and fieldmen, rapidly and growingly equipped with apparatus and literature, backed by generous grants and above all having at its head an officer as capable as he was enthusiastic, the Mycological laboratory at Pusa flourished and proceeded to establish a unique record of extensive and valuable work in Plant Pathology and Systematic Mycology. It is only natural, then, that in any account of such work in India, Pusa should have a very large share. While at Dehra Dun from 1902 to 1905 Butler was chiefly engaged in a preliminary survey of the important fungus diseases of Indian crops. True to his Irish instinct, he early turned his attention to the potato crop and one of his very first publications was 'Potato diseases of India' in 1903. An account of 'Some Indian forest fungi' appeared in the *Indian Forester* in 1905 and the following year there were three more important papers entitled 'The wilt disease of pigeon pea and pepper', 'Some diseases of palms' and 'Fungus diseases of sugarcane in Bengal'.

In 1903, the 'Indian Wheat Rust Problem', part I, by Butler was published as Bulletin, No. 1 of the Imperial Department of Agriculture but a much fuller account of the wheat rusts of India appeared in 1906 as a joint memoir by Butler and J. M. Hayman, Dy. Director of Agriculture, U.P. The following year Butler published an interesting paper called 'The bearing of Mendelism on the susceptibility of wheat to rust' in the *Cambridge Journal of Agricultural Science*.

In 1906, Butler described a serious epidemic of disease in palmyra, cocoanut, and areca palms in the Godaveri Delta. The palmyra palm was attacked most, the cocoanut palm less and the areca palm, the least. The fourth palm in these parts, viz. the date palm (*Phoenix sylvestris*) was observed to be immune. The disease is said to have first appeared in Addunkivarilanka, an island in the north channel of the Godaveri. It takes the form of a destructive bud rot, the cause of which was determined as being *Pythium palmivorum* later re-named as *Phytophthora palmivora*. The parasite enters through the outer leaf sheaths and as soon as it reaches the young soft tissues of the unexpanded leaves, it spreads with great rapidity and soon destroys the centre of the bud. According to McRae the infection is spread from tree to tree by means of tappers and also the rhinoceros beetle *Oryctes rhinoceros* Linn. In very bad cases all the leaves of the crown are shed and the palm is reduced to a bare

pole. The flow of toddy from diseased palmyra palms is checked soon after the death of the central shoot and in cocoanut palms the fruit is affected. Control operations were started in 1906 and consisted chiefly in cutting away the tops of diseased palms, gathering them together and burning them, and applying Bordeaux mixture to the leaf sheaths within a 25 yard radius of the diseased palms. In a few years' time the results were definitely encouraging and the campaign against the disease was decidedly successful.

An investigation of the sugarcane diseases of India, begun at Dehra Dun in 1905, was continued at Pusa for a number of years and resulted in an account by Butler in 1906 of the fungus diseases of sugarcane in Bengal and in joint publications in 1913 by Butler and Abdul Hafiz Khan, now at the Forest Research Institute, Dehra Dun. Besides the well-known *Colletotrichum falcatum* Went causing the red rot of the thick varieties of sugarcane in India, two other Deuteromycetous fungi, viz. *Cephalosporium Sacchari* Butl. and *Hendersonia Sacchari* Butl. also cause symptoms not too easily distinguished from those of *Colletotrichum falcatum*. Fortunately these have not proved to be dangerous pests. Work on sugarcane mosaic, a virus disease, was begun much later at Pusa and continued for a number of years. Cases of this disease were reported from all the provinces in India. At Pusa the size of Red-Mauritius canes was greatly reduced due to mosaic of long standing.

Systematic work also received attention. In 1906, there appeared jointly by H. P. Sydow and Butler the first of the valuable descriptive lists of fungi entitled 'Fungi Indiæ Orientalis'. The works published in 1910 included descriptions of a new genus of the Uredinaceæ by Butler, two new species of the rust *Phakopsora*, two new smuts collected by Butler and described respectively by Dietel, and by H. and P. Sydow, and lastly the rare genus *Pucciniostele* collected by Butler in the Himalayas and described by Dietel. In a descriptive list of fungi published in 1911 jointly by Butler and the Sydows, father and son, one genus and 115 species were new to science and a large proportion of the remainder were species not collected before in India. The same year a new and remarkable aquatic fungus, *Allomyces arbuscula* Butl., found at Pusa was described by Butler as an aberrant member of the family Leptomitaceæ of the Oomycetes.

The year 1907 witnessed an account of some diseases of cereals caused by *Sclerospora graminicola*. It is to Bajra that this parasite does most damage, transforming the ear wholly or in part into a loose, green head composed of a mass of small, twisted leaves with little or no grain. This fungus can prove to be a very destructive pest: I have myself seen fields in Allahabad where about 45% of the plants were destroyed by it.

In the same year, i.e. 1907, an important investigation, begun by Butler at Queen's College, Cork, and completed at Pusa, was embodied in the form of a memoir entitled 'An account of the genus *Pythium* and some Chytridiaceæ' which till very recently was the only comprehensive and authoritative monograph on the genus. Two years later the same author published a memoir containing an account of an important mulberry disease in Kashmir caused by *Coryneum mori* (*Thyrostroma mori*) together with notes on other mulberry diseases. In 1912, there was a paper by Abdul Hafiz Khan on the root infection of the blue pine, *Pinus excelsa*, by the Basidiomycete *Trametes pini* which caused considerable damage into the Simla forests.

A disease of ginger prevalent in Eastern Bengal, Gujarat and elsewhere in India was investigated first by Butler and later by McRae who gave an account of it in the Agricultural Journal of India. The parasite concerned is *Pythium butleri* n.sp. now *P. aphanidermatum*. In bad years nearly the whole crop may be lost. The control measures recommended consisted chiefly of digging out diseased plants by the roots and burning them, not sowing ginger on infected soil for 3 years, not allowing water to stagnate in ginger fields and using healthy seed. In 1919, L. S. Subramaniam, now Assistant Sugarcane Mycologist at Pusa, found the same *Pythium* causing the damping of tobacco seedlings and producing a sort of foot rot in papaya trees. It was he who proposed the name *Pythium butleri* n.sp. (*P. aphanidermatum*) in place of *Pythium gracile* as which the fungus had mistakenly been identified. The well-known fungus *Pythium de baryanum* Hesse., found in the soil at Pusa, was recorded for the first time in Asia in 1913. Sporangia of this species were seen to form much more readily on animal tissues (ants, etc.) than on plant tissues.

A disease of betelnut palms broke out in Mysore, known as the Koleroga disease, the loss from which was estimated at 3-4 lakhs annually. It was investigated independently by Butler and Coleman, both publishing papers on it in 1907 and 1910 respectively. The fungus concerned is *Phytophthora arecae* which attacks a number of other hosts also. An allied species attacks cacao trees in Ceylon and other tropical countries. Applications of Bordeaux mixture saved a large proportion of the areca palms.

The potato blight caused by *Phytophthora infestans* was reported from time to time, mostly from the Khasi hills, Assam, where in places the cultivators felt so helpless as to give up growing potatoes. The three chief causes for the continuance of the disease are, that dead and infected parts of plants are left in the soil, rejected seed is fed to cattle and the dung used as manure, and no rotation of crops is practised. In India the parasite is practically restricted to the hills, principally the

Himalayas, the Khasi hills, and the Nilgiris. Dastur's work brought out the important fact that the fungus cannot survive the heat of the plains. Periodical outbreaks in the Gangetic plain and in the valleys of Assam and Sylhet were found on investigation to be due to infected seed.

The investigation of a disease of *Colocasia antiquorum* caused by *Phytophthora colocasiae* was undertaken by Butler and a joint paper on this work by Butler and G. S. Kulkarni appeared in 1911 in the *Memoirs of the Department of Agriculture*. This parasite has a wide distribution in India and can be very destructive. I saw a luxuriant crop of *Colocasia* in Allahabad almost wiped out by this fungus in August, 1931. Apart from preventing the proper development of the corm in the field, the parasite sets up a dry rot in storage if it has reached the corm. To check the disease, healthy corms must be used for seed, all spotted leaves must be removed and destroyed and shady localities must be avoided for the crop. Bordeaux mixture is beneficial but costly to use.

Phytophthora parasitica Dastur causes a serious disease of castor plants. The disease was investigated and the parasite described by J. F. Dastur in 1912. The chief academic interest in this investigation lay in the discovery of a new mode of reproduction, viz. the 'amphigynous' type of fertilization which consists in the oogonium, piercing and growing through the antheridium.

A very destructive disease occurring in lower Burma and known as the 'Black thread disease of Hevea rubber' (*Hevea brasiliensis*) was investigated by Shaw. It is characterized by the appearance of longitudinal black lines which occur just above the tapping cut and mark areas of disintegration. The flow of latex is decreased but much more serious is the failure of an infected tree to regenerate the bark over the tapped area. In 1914, the loss of rubber was estimated at 2-3,000 lbs. in weight and in 1915 at 8-9,000 lbs. Work on this disease was continued by Dastur and by McRae as Government Mycologist in Madras. The causal organism was finally determined as *Phytophthora meadii* n.sp. by McRae who published from Coimbatore a paper embodying several years' work on this disease in the Botanical series of the Pusa Memoirs in 1917. As remedial measures Dastur recommended thinning out thickly planted areas, removal of diseased fruits and cessation of tapping of diseased trees. In Travancore, McRae and Sundararaman found that rot of the renewing bark could be checked by smearing the affected parts with a mixture of tar and tallow.

Great loss was caused in Bengal from about 1920 onwards, by a sudden wilting of betel vines (pan). Of the three parasitic fungi isolated from diseased vines, *Phytophthora* was found to be the active agent in the monsoon and was later identified as a strain of *Ph. parasitica*. Comparative cultural work on *Phyto-*

phthora meadii, and *P. palmivora* was begun about 1926 and continued in the years following.

Cinchona trees in the Mungpoo and Mungsong cinchona plantations were found to be subject to three diseases—Pink disease, Bleeding disease, and Seedling disease. In Pink disease which is fairly common on the plantations, the bark is injured. With Bleeding disease is sometimes associated a rust-like staining of the bark. Observations on this disease were inconclusive. Seedling disease in Mungpoo resulted in the death of seedlings in very wet weather or in over-watered nurseries. *Phytophthora* was isolated and found to be parasitic. Oospores of this *Phytophthora* were not formed in pure cultures but appeared in mixed cultures with certain other species.

An account of *Rhizoctonia solani* on jute, cotton, potato, ground-nut and cow-pea by F. J. F. Shaw was published from Pusa in 1912. Shaw made the interesting discovery that the spore stage of the fungus, hitherto considered sterile, appeared only on the infected living jute plant, and reverted in artificial culture to the sterile sclerotial condition indistinguishable from the form identified previously as *R. solani* Kuhn. He also showed that there is specialization of parasitism in *Rhizoctonia*. Continuing his work on this form genus he published jointly with Ajrekar in 1915 a paper in which *R. napi* West (*Sclerotinia sclerotiorum*) and *R. destruens* Tass. (*Sclerotium rolfsii*) were described. *R. napi* is a dangerous parasite of mustard and gram but luckily this fungus is incapable of active growth at temperatures above 29°C., a fact which limits its depredations in India. *R. destruens* (*Sclerotium rolfsii*) was found to be the cause of a serious disease of *Piper betel* and potato in lower Bengal, Behar, and Bombay Presidency. As *Rhizoctonia* can perennate from season to season by means of its sclerotia and sterilizing the soil is not practicable on a large scale, it was suggested that experiments might be undertaken to test the starving out of the fungus in the soil by not sowing for some seasons any crop susceptible to it. The foot rot of the betel vine caused by *Rhizoctonia solani* Kuhn. and *Sclerotium rolfsii* have been checked by applications of Kerol and Phenyl at Pusa. The first of these parasites was found to cause the stem rot of berseem (*Trifolium alexandrinum*) in 1925.

An important non-fungoid disease worked on for some years by Butler perhaps deserves mention. This was the 'Ufra disease' of rice in Bengal caused by an eelworm *Tylenchus angustus* Butl., which can live for at least 8 months if fully dried and for about 2 months if fully immersed in water.

In 1916, extensive trials of spraying peach trees against 'leaf-curl' caused by *Taphrina deformans* were carried out near Peshawar by Shaw and Robertson Brown, Agriculture Officer, N.W. Provinces, the results being distinctly encouraging.

Shaw also investigated apple mildew caused by *Podosphaera*. This is one of the most widely spread of the apple diseases in Kumaon, U.P. Spraying operations in 1919 in Kumaon and Peshawar, using home made sulphur and Berger's sulphur with lead arsenate added in each case, largely controlled the disease.

Dastur studied the sugarcane smut caused by *Ustilago sacchari* Rabenhorst (Uscitaminea) and discovered the somewhat unique mode of infection, the fungus entering through the hairs on the scales of the young shoot bud. Older buds can only be infected if wounded or injured.

A study of the genus *Helminthosporium* on cereals and sugarcane was commenced at Pusa in 1918 by M. Mitra and has since been continued. The work was started with special reference to the relationship between species on wild grasses and on cereals and other crop plants. Except in the case of the stripe disease of Barley where the ear becomes distorted, the symptoms of *Helminthosporium* on the various cereals are very similar and the most prominent of them are the large, brown, elongated spots on the leaves. Mitra continued his work on *Helminthosporium* during his 2 years' stay in England and published two important papers in the *Transactions of the British Mycological Society*. Even now he is at work on his favourite genus! An allied genus *Acrothecium* also worked on by Mitra, attacks several of the Gramineæ and *Acrothecium penniseti* was known to attack *Bajra* somewhat severely at Pusa.

The wilt disease of pigeon-pea (*Cajanus indicus*) was first studied by Butler in 1905 and the causal organism named *Fusarium udum* which was later identified as *Fusarium vasinfectum* Atkinson. Work on rahar wilt was resumed at Pusa by McRae in 1924 and continued for a number of years. Experiments showed that the bulk of the infection is from the fungus present in the soil and only a small proportion is carried by the seed. Manurial experiments on the Pusa farm indicated that superphosphate encourages and green manure discourages the disease. Two types of *rahar* called WR and Type 80 grown on the manurial plots at Pusa from 1929 to 1931 proved to be very resistant to wilt. A monograph on the 'Influence of manures on the wilt disease of *Cajanus indicus*' has recently been published from Pusa. Wilts of cotton, sesamum, gram, chillies and other crops investigated by Butler were also found to be caused by a parasitic *Fusarium*. The wilt occurred chiefly in sand, sandy loam, and light alluvial soils.

Fusarium vasinfectum and two strains of *Rhizoctonia* have recently been found to cause wilting in *Crotalaria juncea* at Pusa, the damage from the *Fusarium* being much the greater. The strains of *Fusarium vasinfectum* on cotton and sann-hemp appear to be specialized. M. Mitra has found that the pigeon-

pea strain of *F. vasinfectum* can wilt sann-hemp and vice-versa but the strain on cotton can not. Nor can the pigeon-pea and sann-hemp strain wilt cotton and sesamum.

A rot of bananas investigated at Pusa about 1915 was found to be caused by a parasitic *Fusarium* which in severe cases may reach the stem and kill the whole crown. This disease is distinct from the well-known Panama disease of bananas.

In 1926, a *Fusarium* occurring in Manipur State was found to kill rice seedlings and to produce sterile ears in the plants that survived. A similar disease occurred at Gurdaspur and Lyallpur in the Punjab and round about Pusa.

A paper entitled 'Studies in the diseases of the jute plant' by McRae was published about 1924 in the Pusa Memoirs.

The gram blight, caused by *Mystrosporium* which was very prevalent at Pusa in 1930 is also being studied: wet treatment with formalin and uspulun and dry treatment with sulphur and cerasan is being experimented with. *Rhizoctonia solani* was isolated from 25 varieties of gram and proved to be parasitic. It attacks young gram plants.

Abdus Sattar, a post-graduate student at Pusa, worked on the Kodra smut (*Sorosporium paspali* McAlp. on *Paspalum scrobiculatum*) in 1927 and 1928 and found that steeping infected seed in 1.5% CuSO_4 and dusting with copper carbonate before sowing, reduced smut from 50% to less than 1%.

A Deuteromycete, viz. *Macrophomina phaseoli* was found to be the cause of the malformation and proliferation of the young shoots of *Sesamum indicum*.

Specimens of diseased wheat from Karnal, Punjab, showed a new bunt which was described by M. Mitra and named *Tilletia indica* Mitra n.sp. In 1932, the damage caused by this bunt was up to 20% in some fields in Karnal. Unlike *Tilletia tritici* (*T. caries*) and *T. levis* (*T. foetens*), this new species destroys the embryo but leaves the endosperm unaffected. *Tilletia indica* seems to be restricted to the cooler regions of the plains and *Tilletia tritici* (*T. caries*) and *T. levis* (*T. foetens*) to the hilly tracts in India. B. B. Mundkur has published a note on the dry spray method of treating oat seed against covered smut. He found concentrated formaldehyde, 1 lb. for 24 maunds of oat grains to give excellent results. He has also obtained the sexual stage of *Sclerotium rolfsii* which is tentatively held to be *Corticium rolfsii*.

In 1932, Pusa undertook the study of a species of *Alternaria* which caused considerable damage to tobacco on the Rangpur farm in Bengal.

Cercospora dolichi, unlike most of the comparatively harmless species of this genus, was seen to be a virulent parasite on *Dolichos lablab* (broad bean), all the aerial parts of which it attacks. Udaibhan Singh published a paper on the physiology of this fungus in 1933. His paper entitled 'Studies on *Cercospora*

indica n.sp.' was published in the *Indian Journal of Agricultural Science* in 1934. This fungus is parasitic on the leaves of *Cajanus indicus* at Pusa and Allahabad.

Provincial Agricultural Departments.

We shall now turn our attention to the Provincial Agricultural Departments. Much has been done by the Mycologists in these departments and much is expected of them.

Madras.—The work of McRae, at first Supernumerary Mycologist at Pusa and later Government Mycologist at Coimbatore, on the Hevea rubber disease caused by *Phytophthora meadii*, has already been mentioned. In recent years Srinavasayya from the Institute of Science, Bangalore, has worked on the transmission of this disease. The brown blight of tea caused by *Glomerella cingulata* did considerable damage to the nurseries in the Madras Presidency in 1917, and was studied jointly by McRae and Anstead. Spraying with Bordeaux mixture proved useful. In Madura district grape vines were successfully sprayed against mildew with this fungicide. It was claimed that the yield from 239 vines rose in value from Rs. 710 to Rs. 3,950 as a result of spraying. The life-history of *Ustilago crameri* on *Setaria italica* was worked out at Coimbatore and described in a bulletin in 1920.

A ginger disease in the Godavari district, caused by *Vermicularia zingibræ* (*Colletotrichum zingiberis*) and resulting in the rotting of the tender shoots, was fully described by Sundararaman in a Pusa Memoir, published from Coimbatore in 1922. A bulletin published the same year described the cocoanut stem-bleeding disease caused by *Thielaviopsis paradoxa* (*Ceratostomella paradoxa*). Control measures consisted in scooping out all the diseased tissues and applying hot tar. The fungus was found to be the same as that which also causes the stem-bleeding disease of the areca palm.

Sugarcane mosaic was studied at Coimbatore in 1928 and found to reduce the yield of canes. Infection was through the setts and by insects.

Sundararaman and Rama Krishna investigated the Mahali disease of cocoanuts in Malabar. The disease is caused by *Phytophthora arecæ* which in the rainy season attacks the nuts so that they fall off. Spraying with Bordeaux mixture before the monsoon was recommended. A leaf-spot and blight disease of onions caused by *Alternaria palandui* Rangaswami was described in a bulletin published from Coimbatore in 1928.

Mysore.—The advanced native State of Mysore has for many years employed the services of a Plant Pathologist, which has resulted in a considerable outturn of good work. Some of this work was naturally done in collaboration with the Madras Mycologist and furnishes a good example of healthy

co-operation between two neighbouring scientific departments.

The black rot of coffee caused by *Corticium koleroga* was investigated by the Mysore Mycologist L. C. Coleman. Two alternate hosts belonging respectively to the Rubiaceæ and the Oleaceæ were discovered for this parasite. In 1933, Narasimham published a paper in *Phytopathology* where the morphology of the fungus is further elucidated. Regular pruning and spraying with Bordeaux mixture controlled the disease. Coleman also worked on the spike disease of sandal wood. More recently Narasimham has made a contribution to the Cytology of the Spike disease of *Santalum album*. The same worker published a paper in 1930 on 'Heterothallic strains of *Phytophthora*'. In addition to *Phytophthora arecæ*, he worked with seven strains of *Phytophthora* collected in Mysore from a variety of hosts. *Fomes lucidus* (*Gonoderma lucidum*) was found to be the cause of a root disease of areca palms in Mysore. Coleman found trenching and heavy liming to be effective.

Baroda.—In the Baroda State Likhite has been at work on tomato virus and other plant diseases. He and S. L. Ajrekar have published their observations on the Bajra smut *Tolyposporium penicillariæ*. Work on the root rot of cotton is now in progress in this State.

Bombay.—The presidency of Bombay has had a devoted band of workers who have studiously applied themselves to a study of their problems in Plant Pathology.

G. S. Kulkarni made a detailed study of the smuts of Jowar in Bombay, the work having been done partly at Pusa. These smuts are *Sphacelotheca sorghi* and *S. cruenta*, *Ustilago reiliana* (*Sorosporium reilianum*) and *Tolyposporium filiferum*. At Kulkarni's recommendation the Bombay Department of Agriculture carried out a successful campaign against Jowar smuts, the annual loss from which was estimated to exceed a million sterling in the Presidency. Control measures consisted in treating seed with copper sulphate. Ajrekar and Kulkarni worked on the rots of stored potatoes and found that *Fusarium* causes a dry rot and *Rhizoctonia*, a black rot, the latter usually followed by a wet bacterial rot which completes the destruction of the tuber. The four most common potato-rot fungi described were two species of *Fusarium*, *Sclerotium rolfii* and another species of *Sclerotium*. Ajrekar studied the mode of infection and the prevention of sugarcane smut and also investigated a disease of Jowar caused by the conidial stage of a *Claviceps*. Other publications by Ajrekar include joint notes on the life-histories of the rusts *Uromyces alæ* and *Uromyces* sp. on *Jasminum Malabaricum* in collaboration respectively with B. R. Tonapy and S. A. Parandekar and a paper on the Mucorinæ of Bombay by Ajrekar and Dharmarjulu. B. N. Uppal and M. K. Desai worked with a number of dust fungicides to determine how far they were effective in

controlling the grain smut of Jowar. Dusts of copper carbonate, copper sulphate, and sulphur were all effective but sulphur dust proved to be the best.

In December 1932, Uppal and Desai published a paper in which they showed that *Sclerospora graminicola* was really a group species consisting of at least two physiologic forms, the one attacking only Bajra while the other is found on *Setaria viridis*, *S. magna*, *S. italica*, and *Euchlaena mexicana*. In a joint paper by B. N. Uppal and W. H. Weston of Harvard University, U.S.A. in 1932, the authors have revised the systematic position of what had been named by Kulkarni in 1913 as *Sclerospora graminicola* var. *Andropogonis sorghi*. The paper shows that significant differences in the structure of the *Sclerospora* on Bajra and Jowar justify the separation of the latter which they have raised to specific rank as *Sclerospora sorghi*. In cross inoculations *S. sorghi* failed to infect *Pennisetum* or *Setaria* just as *S. graminicola* from *Pennisetum* or *Setaria* refused to attack Sorghum. Uppal and Desai published a bulletin in 1932 on the powdery mildew of cumint in Bombay. In the Bombay Presidency the cultivation of *Cuminum cyminum* is chiefly confined to the Kaira district in North Gujarat where it occupies over two thousand acres. Powdery mildew identified as *Erysiphe polygoni* is the most common and a very serious disease of cumint in these parts. If the disease appears at the time of flowering, the loss may amount to 50% of the normal yield.

A very useful investigation was undertaken by Uppal, Cheema, and Kamat on the powdery mildew of the grape in the Bombay Presidency. Its cultivation is chiefly but not wholly confined to Nasik and its vicinity. The parasitic mildew is *Uncinula necator* but the perithecia which are responsible for the name do not occur in the Bombay Presidency and the fungus perennates by means of hibernating mycelium in the dormant buds of the vine and spreads by means of its conidia. Leaves, shoots, blossoms, and berries are all attacked. The disease is at its worst in the cold weather and is known to have caused wholesale destruction in untreated vineyards. Bordeaux mixture did not check infection and the most effective control of the mildew was secured with sulphur. Judicious treatment with finely ground sulphur resulted in leaving the vines practically free from mildew. 75 to 80 lbs. of sulphur per acre suffice for the three applications required and the maximum cost including labour is within 7 rupees.

Central Provinces.—In the Central Provinces a number of fungoid plant diseases were investigated by the Government Mycologist J. F. Dastur. He studied the foot-rot disease of *Piper betel*, and the Striga disease of Jowar and sugarcane. Treating the infected cane clumps with copper sulphate was found to be successful. The anthracnose of cotton bolls caused

by *Colletotrichum indicum* n.sp. does considerable damage in C.P. The disease is seed borne. Treating the seed with uspulun, sulphuric acid or copper carbonate was found to be effective. *Phytophthora parasitica* nov. spec. described by Dastur has already been mentioned. Species of *Fusarium* isolated from cotton plants and from the soil in C.P. by Jiwan Singh were, in inoculation experiments, found incapable of infecting healthy cotton plants. Buri cotton was found to be immune to wilt and although it yields less than other varieties in C.P., it is useful for wilt-infested areas. Gram wilt was also investigated.

United Provinces.—In the United Provinces the excellent work done on Indian Wheat Rusts by J. M. Hayman in collaboration with Butler has already received mention.

Experiments on the storage of potatoes, begun about the year 1914 have for some years, formed one of the chief items of work and very satisfactory results were claimed to have been obtained from experiments on storing seed and food potatoes at low temperatures.

S. D. Joshi, Research Assistant, Plant Pathological Section, U.P., published a memoir in 1924 on the wilt disease of safflower. He found the causal organism to be *Sclerotinia sclerotiorum*, the sclerotia of which appear to live for only a little over a year and are killed by a 5 minute immersion in water at 50°C.

The Government Plant Pathologist P. K. Dey published a paper in 1933 entitled 'Studies in the physiology of the appressorium of *Colletotrichum glaucosporoides*' in which he showed that the germination of the appressorium takes place only in the presence of nutrient substances which diffuse out through the uninjured cuticle of the young leaves into drops of water placed on them. Dey has also worked on soft rot of Indian apples caused by *Aspergillus niger*. The fungus can enter the apple only where it is injured. Sour apples seem to be more susceptible.

Assam.—In Assam the Mycological Assistant has been at work on a number of fungous diseases.

The 'yellowing disease' of oranges was studied and a species of *Fusarium* isolated, but no definite results have yet been obtained. It is possible that the disease is physiological and not fungoid.

Betel vine wilt which causes serious damage in Assam has also been investigated and species of *Fusarium* and *Rhizoctonia* were isolated.

The potato blight has been kept in check by spraying with Bordeaux mixture. Experiments are in progress to discover resistant varieties of potato.

The collar rot of sugarcane caused by *Melanchonium sacchari* has been kept in control by sett selection. *Glæosporium* regularly attacks the leaves and fruits of limes and lemons in Assam.

Punjab.—The Punjab has not always taken fungoid plant Pathology very seriously, considering it has never engaged a whole-time Mycologist and in 1912 dispensed with the services of an Assistant Professor of Mycology within two years of his appointment, to make room (or rather funds) for an Agricultural Engineer. It is therefore all the more creditable that the study of fungoid diseases has not been wholly neglected in the Punjab and it is gratifying to find that there is now a Mycological Assistant at Lyallpur. At the moment of writing I have in my hands three good publications from the Punjab which have appeared in the *Indian Journal of Agricultural Science*.

Jai Chand Luthra, Associate Professor of Botany and Kishan Singh Bedi, Mycological Assistant, Punjab Agricultural College, did joint work on the gram blight with reference to its cause and mode of perennation. The disease causes serious damage to the gram crop in North Punjab. Isolation and inoculation experiments proved the parasite to be *Phyllosticta rabiei* and the disease was found to be seed-borne.

B. L. Chona described a number of banana diseases occurring on the plantations and in the curing pit at Lyallpur. The parasites responsible for the most important of them were species of *Glæosporium* and *Botryodiplodia*. These have been described at length and methods of healthy propagation of young suckers and of curing fruits free from disease, have been dealt with.

A third paper published jointly in 1934 by Jai Chand Luthra and Abdus Sattar, Research Assistant, Punjab Agricultural College, is entitled 'Some experiments on the control of the loose smut of wheat, *Ustilago tritici*'. The authors state that while the damage caused by this smut is usually slight, there was a serious outbreak of it in 1923 in the upper and lower Jhelum canal colonies which resulted in some cases in a 30% infection. The experiments described deal with a simplified method of the hot water seed treatment, a single-bath, sun-heated water method and two new methods in which solar energy is used for heating the water for seed treatment.

The Indian Tea Association.

The Indian Tea Association has not been idle and A. C. Tunstall has studied several diseases of tea. The number of parasites on tea is very large but prominent amongst diseases of this crop in India are the Blister Blight of tea caused by *Exobasidium vexans*, Brown Blight caused by *Glomerella cingulata*, Copper Blight produced by *Laestadea camelliae* Cke., Grey Blight caused by *Pestalozzia theae* Sawada, Stump rot produced by species of *Rosellinia* and *Ustilina* and Red Rust which is caused by the alga *Cephaleuros mycoidea*. Of these, red rust

is considered by some to be the most serious blight of tea in North-east India. Brown Blight was investigated by McRae jointly with Coleman and Anstead. Blister Blight had long been known in Assam and an account of it was published as far back as 1868. Harold Mann, Scientific Officer to the Tea Association, reported on it in 1906 but it was not regarded as a serious menace to the tea industry until it broke out in 1910 in the Darjeeling hills where it resulted in considerable loss. The life-history of the parasite was worked out by McRae at Pusa. Of the fungicides used against Blister Blight, Burgundy Mixture was probably the most efficient. Amongst the root diseases of tea those caused by species of *Rosellinia* and *Ustulina* are perhaps the commonest.

A *Nectria* was found by Tunstall to be the cause of a stem disease of tea in Darjeeling. It enters through the wounds made by the pluckers.

Tunstall and Andrews published notes on the spraying of tea in 1915.

The Forest Department.

Coming to Forest Plant Pathology and Mycology, we find that the earliest papers were published in the *Indian Forester* in 1876 to 1879 in which M. C. Cooke described a large number of fungi collected by J. S. Gamble. Subsequently, from 1889 to 1892, there were more such papers by the I.M.S. officers Barclay and Cunningham. In 1895, J. Nisbet published short notes on the occurrence of rots and cankers, the causes of which remained mostly undetermined. This was followed by a list of some Indian fungi by Gamble in 1899. In the next few years there were a number of brief publications by various authors amongst whom were Troup, Fernandez, Brandis, and Coventry. In 1905, Butler made a careful systematic study of some of the important forest fungi and published a series of articles in the *Indian Forester*. Between 1910 and 1914, other workers, notably R. S. Troup and R. S. Hole published the results of their mycological, pathological, and ecological researches.

The 'spike disease' of *Santalum album* first received detailed mention by a Dy. Conservator of Forests as far back as 1899. Butler worked on the disease in 1902 and an exhaustive monograph was published by C. A. Barber, Government Botanist, Madras, in 1906-7. This disease of sandal wood was one of the most interesting of the problems that engaged the attention of forest officers, a number of whom including Benson and Lushington published preliminary notes and papers on this disease. In a paper published by him in 1917, R. S. Hole postulated the theory of unbalanced sap circulation as the cause of sandal spike disease and this resulted in a number of contro-

versial articles by several workers in the *Indian Forester* from 1917 to 1927. Probably the latest opinion on the subject is that this disease is due to a virus, or partly to a virus and partly to physiological causes. The Institute of Science at Bangalore, the Mysore State Officers and the Madras Forest Department are now all at work on the problem and, being on the spot, are better able to tackle it than Mycologists at the Forest Research Institute at Dehra Dun. A study of wood-rotting fungi, started by Butler, was continued by a number of forest officers. Hole took up the study of the well-known forest fungus *Trametes pini* which has been exhaustively studied by Hartig and other Mycologists in Europe. Abdul Hafiz Khan worked on the root infection of this fungus. Two other fungi of the same class which are dangerous parasites in hill forests are *Fomes annosus* var. *indica* on *Picea morinda*, *Abies pindrow* and *Cedrus deodara*, and *Armillaria mellea* on *Picea morinda*.

In recent years some excellent work has been done by the Forest Mycologist K. D. Bagchee the results of which are contained in two comprehensive papers published in the *Indian Forest Records* in 1929 and 1933. These papers deal with *Peridermium complanatum* on the needles of *Pinus longifolia* and the biological connection between *Peridermium himalayense* n.sp. on the stem of *Pinus longifolia* and *Cronartium himalayense* n.sp. on *Swertia* sp.

The work now in progress in the Mycological Section of the Forest Research Institute, Dehra Dun, includes a study of the various rusts on forest trees, the investigation of the diseases of Sal (*Shorea robusta*) in the United Provinces, Behar and Orissa, Assam and Bengal, a study of some of the common Indian wood-rotting Polypores and other Auto-Basidiomycetes, the determination of the various dry rot organisms, the investigation of the so-called 'die-back' diseases, canker diseases, and nursery diseases such as 'damping off' and of the fungi causing 'witches-brooms' on forest trees.

The Universities.

Amongst the Universities in India those which have more particularly turned their attention to the study of fungi are the Universities of the Punjab, Agra and Allahabad, all of which have made a real contribution to the advancement of Mycology and Plant Pathology in this country. At the Botanical Laboratory in Lahore Dr. H. Chaudhuri and his students have worked on a variety of fungi including soil, aquatic and coprophilous fungi, slime moulds and mycorrhiza. Chaudhuri and Singh have published a paper in the *Annales Mycologici* on certain soil fungi found at Lahore. Nazeer and Mohammad Asghar have worked on Indian coprophilous fungi, while there is a very

well-got-up monograph by Sher Mohammad Lodhi containing descriptions and figures of several species of Indian Myxomycete, collected by the late Mrs. Drake, wife of the Rev. John Drake of the Serampur College, Bengal. Chaudhuri and his students Raja Ram and Akhtar have published two or three papers on endotrophic mycorrhiza, while certain water moulds of the Punjab have been worked on by Chaudhuri and Prakash Lal. Under Chaudhuri's guidance, some diseases of apples in Northern India were studied by Pushkar Nath and Chinna and diseases of tea in the Kangra Valley, by Chinna, Kapur, and Dharam Kishore.

Certain bacteria and bacterial diseases were also studied by Chaudhuri, including the bacterial disease of wheat and the root-nodule organism in *Casuarina*. Other notes and publications from the Lahore Botany Department include for their subjects the wither-tip of Citrus by Chaudhuri and Gopal Singh, diseases of Pomegranates by Chaudhuri and Jagtar Singh and *Capnodium* on Cotton by Sawhney. Amongst the publications relating to physiological studies in fungi from this laboratory may be mentioned the effects of X-rays and Ultra-violet rays on certain fungi by Jagtar Singh and by Sher Ahmad in the 'Proceedings of the Indian Science Congress of 1933 and 1934' respectively.

Fungus work in Allahabad resolves itself chiefly into three kinds—the collection and identification of Indian fungi, work with natural media prepared from Indian fruits and vegetables with a view to ascertain their nutritive value, and thirdly, detailed cultural studies of various fungi. A certain amount has also been done in the line of investigation of fungal plant diseases but not nearly enough. The constant collection of fungi in various places has resulted in the preparation of a number of lists of fungi by Kanhaiya Lal Saksena, now on the staff of the Victoria College at Gwalior, by Mitter and Tandon, and by Dr. H. Sydow of Berlin and Mitter. The last of the lists describes a new genus and a number of new species. The second of the descriptive lists of Indian fungi by Sydow and Mitter in 'Annales Mycologici' includes 2 new genera and 18 new species.

R. K. Saksena is doing good cytological and biological work on *Pythium deliense*, and some of this work has already been published.

Anil Mitra has submitted six or more papers, amongst which may be mentioned 'The effect of various carbohydrates on the growth of certain *Fusaria*' and a preliminary report on 'A new wound parasite of potato tubers', the last appearing in *Nature* in January, 1934. He has also found that *Fusarium moniliforme* can parasitize both the 'hill' and the 'Kashmir' varieties of apple.

A very good paper was submitted by R. C. Lacy, now Lecturer in Botany in the Prince of Wales Medical College,

Patna, entitled 'An estimation of the comparative value of various fresh fruit media in regard to fungal growth'. J. P. Bhatnagar did similar work with fresh vegetable media. Other M.Sc. students also did cultural work with various fungus strains and submitted some good papers. An interesting series of inoculations made by Shanti Nagar revealed the parasitic activity of certain well-known moulds which produced artificial rots on a number of different fruits. R. P. Asthana, worked on local strains of *Aspergillus* and *Penicillium* and Miss Leila Roy on the genus *Macrosporium*.^{*} Descriptive work on the local Peronosporaceæ, Deuteromycetes and the Polypores of the Central Provinces was done by J. M. Merh, R. N. Sharma, and P. R. Bhagwagar respectively. Bhagwagar also made a comparative cultural study of certain Helminthosporia. Much of the students' work deserved publication and it is largely my fault that it has not seen the light of day.

At the Agra University, while Plant Pathology has been so far chiefly a one man's show, it has been so good a show that it defies any adverse criticism. We are all more or less acquainted with the excellent work of Professor K. C. Mehta of the Agra University who began his work on the annual recurrence of cereal rusts at Cambridge in 1920 and since 1923 has steadily pursued a study of the same problem in India. The success of his investigations won over the Imperial Council of Agricultural Research who have given him adequate facilities to carry on this very important work. Mehta's theory, supported by ever-increasing data, with regard to the annual outbreaks of the black, brown, and yellow rusts (*Puccinia graminis*, *P. triticea* and *P. glumarum*) in the plains of India is, that they are caused by wind-blown uredo-spores disseminated from the hills where they oversummer. While the yellow rust of wheat and barley has not been found to survive below 6,000 ft. above sea-level, brown rust was found to oversummer at Almora at about 5,400 ft. and black rust even at lower altitudes of 3,000-4,000 ft. So far as the plains are concerned, species of *Berberis* and *Thalictrum*, the alternate hosts for *Puccinia graminis* and *P. triticea*, do not appear to be directly responsible for the annual outbreak of those rusts. *Aecidium* on *Thalictrum* is probably more common on the hills than is thought because I myself found good and abundant specimens of this at Nainital in June, 1933 but the rôle of *Thalictrum* as an alternate host is, according to Mehta, still very doubtful. The data obtained so far clearly indicate that the foci of infection in the case of all three rusts occur in the hills and Mehta therefore rightly concludes that a unique opportunity for tackling the cereal rust problem in India is offered by the facts that the suspected alternate hosts *Thalictrum* and *Berberis* are absent in the plains and the uredo-spores are unable to survive the summer except in the hills where the area under wheat and barley is only about 5% of the

total area acreage of these crops in India. The dissemination of uredospores has been studied in most parts of the country by means of greased slides exposed in aëroscopes or sent up on kites, and valuable information has thus been obtained with regard to the directions in which these wind-borne spores usually travel.

Experiments have also been in progress to discover physiologic forms, of which only four for black rust and two for brown rust have so far been discovered. A joint scheme for the continuance and expansion of this work together with the breeding of varieties of wheat resistant to these physiologic forms, has recently been approved by the Advisory Board of the Imperial Council of Agricultural Research.

In the Calcutta University, S. R. Bose of the Carmichael Medical College, Calcutta, is an expert on the Polyporaceæ of Bengal on which he has published a number of papers. Bengal Polyporaceæ part X has recently been published. Bose's publications on Golgi bodies in the higher fungi may be found in *Nature* and in *Annals of Botany*. The results obtained by him in his later investigations confirm his observation that the vacuolar bodies in plant cells probably represent the Golgi bodies of animal cells. The author criticises Bowen and Gatenby for attempting to establish the generalization that Golgi bodies occur in all plant cells. Bose did not get them in some Basidiomycetes he worked with.

A paper on 'Theories of Sex in Fungi' published by Bose in 1932 was followed by a much fuller account of similar work on the Sexuality of *Polyporus ostreiformis* and *Polystictus hirsutus*. This second paper appeared in "La Cellule" in 1934. The author showed that these two fungi were strictly heterothallic and bisexual species. He further made the interesting discovery that the white line of aversion or the linear space left where two monosporous mycelia met was, in the case of these two species, not related to sex, since such lines of aversion occurred between haploid as well as diploid mycelia.

Other investigations by Bose include 'Biology of wood-rotting fungi common in forest areas', 'The true nature of nuclear division in *Tradescantia* stems' and 'Possibilities of mushroom industry in India'.

The Future.

Let us now turn to the future.

That there is a vast unexplored field for Mycology in India is borne out by Butler who says in his presidential address to the British Mycological Society in 1930 'We are still, however, only on the fringe of real knowledge of tropical fungi'. In their book, 'The fungi of India' published in 1931, Butler and Bisby say—'The present list of 2,350 species of fungi recorded

from India obviously includes but a small fraction of the total that occurs there' (in India). And later, '..... it may well be that no more than 10% of the fungi of India are recorded, and many of those recorded are doubtful'. Not enough is known even of groups such as the Meliolineæ and the Nidulariaceæ which are almost exclusively tropical. A large number of species have been newly recorded in India in recent years but we can hardly congratulate ourselves that the progress in systemic Mycology even in the last decade is anything like as satisfactory as it needs to be. Lists of fungi do appear from time to time but not half so frequently as they might, and one hopes that students of Mycology will in increasing numbers engage in the pleasant and useful pastime of making fungus collections and describing them. Not only do our hills maintain an untold wealth of fungus life but even the plains in many parts of the country harbour enough fungi to justify unceasing search for them. I think we must admit that this work has not had the enthusiasm which it deserves. Not only do teachers in the Universities rarely care to make fungus collections, but even Government Mycologists, with ample facilities for travelling, have in most cases not thought it worth their while to collect or describe fungi other than the few parasites which specially interest them. I do hope that besides others, teachers and students in the Indian Universities, with an academic outlook worthy of them, will in the future undertake to enrich our knowledge of the fungi of our country. Since collections made in India have still often to be sent abroad to Europe or America to be named, we might do well to bear in mind some remarks by Miss E. M. Wakefield in her presidential address to the British Mycological Society in 1930. Talking of the assistance required from collectors, she says 'yet he could provide much valuable information if, when he does collect, he would jot down notes as to habitats, colours, host ranges, seasonal occurrence, even the degree of rarity—in fact any points which to him as a Botanist, appear to be worth recording'. Again, 'To those who wish to have their collections well named, I would say, send ample material and do not be afraid of sending again and again, especially from new localities'. 'The ideal arrangement' she says 'would be to have in each colony, in addition to a Pathologist, a Mycologist who could give his whole time to taxonomic and floristic work'.

Like Mycology, Plant Pathology also has a great future before it in India, because while we are still struggling against known fungal parasites, new diseases are all the time making their appearance and knowing, as we do, that the annual damage to crops and trees from fungus pests is to be estimated not in thousands but in lakhs and crores of rupees, the importance of the subject assumes tremendous proportions. The primary need is for more Plant Pathologists. The fungi are plenteous

but the workers are few. In the address from which I have already quoted, Butler says 'At the present time there are about a dozen Mycologists with a large number of assistants, at work in India, a number all too few for the requirements of the country'. Where are the additional much needed Pathologists to come from? It has been the attitude in our country to look to Government for help in all such matters. But, to be fair, Government have done and are doing their bit. To most of the provinces they have given Plant Pathologists with assistants and well-equipped laboratories, and in recent years they have made further grants available for such work through the Imperial Council of Agricultural Research. The only misfortune in this connection has been that efficient, well-trained Plant Pathologists have not always been available in the past to fill even the higher Government posts. It is to the Universities in India that we must chiefly look, to provide men with at least an elementary training in Plant Pathology. One or two of the Indian Universities already have well-organized post-graduate courses in the subject. Let the other Universities follow suit. I do not forget that Universities are academic bodies and must foster an interest in all the various branches of Botany, but I think that keeping in view the present needs of the country, they might with advantage specialize more particularly for some years to come, in the economic and agricultural branches of Botany, deeming it a privilege to train men who will be of real use to the motherland. There are at present so many openings for our youths to enter the brilliant and better paid professions through competitive examinations, that the best of them are often not attracted to a scientific career. At the Allahabad University an M.Sc. Botany candidate is allowed in his final year to substitute a thesis in Plant Pathology or Plant Physiology for one of his theory papers, and this year and the last, there has been a falling off in the number of students offering these. Research work takes its time and our students have apparently thought it more profitable to avoid the laborious work required for a thesis and find more time to prepare for one of the competitive examinations simultaneously with their M.Sc. studies. But these ambitious young men have to be reminded that luck in competitive examinations is only for the chosen few and therefore not all of them can afford to despise a scientific career as a means of livelihood. Teachers of Plant Pathology must of course do what they can to make the subject attractive. A good museum speaks for the enthusiasm of a teacher who must lose no opportunity to collect and preserve specimens. Dried specimens, properly arranged, can form the nucleus of a humble herbarium and a stock of useful cultures can easily be maintained. A good culture-room where inoculations can be made under clean, fairly aseptic conditions, is a great desideratum. I dare say these things are more or less being done, but I think

University Botanical departments might go farther, wherever funds permit, and construct a pot-culture house where students can carry on little inoculation experiments under suitable conditions. An excellent and comparatively economical pot-culture house devised by Dr. K. C. Mehta can be seen in his Botanical Garden at the Agra College and also up at Simla. This is hard to beat but a much simpler structure would suffice for students' work.

For the rest, plenty of field-work is enjoyed by students and is very useful for them. The value of Mycological excursions to out-stations can hardly be questioned but this means expense and it is up to the Universities to supply the funds as adequately as they can. The Punjab University, for example, allots a generous sum annually for Botanical excursions and who can doubt the advantage this gives to its students over those who are denied such facilities?

There is another source for the recruitment of Indian Plant Pathologists and I hope I shall not be considered a mere dreamer if I mention it. There is no reason why the sons of rich zemindars should not make a hobby of Plant Pathology. The one ambition of our post-graduate students, alas, is to enter service and we can hardly blame them for that. But there are rare occasions when it does one good to know that a young man is going through a course in Botany or Agriculture, not with the ulterior object of getting a job but to be an educated zemindar. As time goes on, this class of student will be more frequent and it is for us to attract such men to Plant Pathology, a knowledge of which is bound to be of immense value to them in increasing the yield from their land.

I now come to the very important question of co-operation. If we are to deal with fungoid plant diseases in this sub-continent with any measure of success, we must call to our aid all the co-operation of which we are capable. The provincial agricultural departments in India have not failed to take advantage of the valuable co-operation of the Imperial Agricultural Research Institute at Pusa and this was only natural because not only has Pusa unfailingly come to their aid in all their difficulties, but the investigation of some of their major problems was started by the Imperial Mycologist and what is more, the Mycological assistants supplied to the provinces have in most cases been trained at Pusa. The provincial Mycological departments are thus under a real debt of gratitude to the parent Institute at Pusa and one can only hope that the useful co-operation between the two will continue to the advantage of both.

Between the Imperial Mycological Section and the Universities, however, there has, so far been little or no co-operation, and dealings between the two have been one-sided, consisting chiefly in requests from the Universities to send or name

Mycological specimens. More than this is wanted and can be done. I remember an eminent Indian Botanist telling me that the life-histories of many of our fungoid parasites remained uninvestigated and it was very desirable that this work should be taken in hand. Now we know that the Imperial Mycologist has to work for the whole of India and often has too much miscellaneous work to find time for a minute or complete investigation of every fungoid pest he deals with. Measures of control have often to be recommended before the life-history of a parasite has been completely worked out. It is here, for instance, that the Universities could come to the aid of the Imperial Mycologists. If a fungoid plant disease occurred in Lucknow, Lahore, or Nagpur, it would be a suitable problem for a student Mycologist or member of the University Botany Staff at that place to work out the life-history of the parasite concerned, such work being of academic as well as economic importance. Fungus cytology offers another excellent field for research at the Universities in India and some of the many young men now going abroad to Europe for Botanical training may well specialize in this line. Problems relating to sex such as heterothallism, biologic forms and the like are also subjects on which valuable contributions may justly be expected from the Botanical departments of Indian Universities. The physiology of parasitism and the reactions of fungi to stimuli are yet other phenomena on which we want more light from workers on Indian fungi and if the Universities can undertake such work, it will constitute an exceedingly important form of co-operation with the work of the Imperial Mycologist. The need for such co-operation is at once evident when we consider that the actual damage done to a plant by a fungus is by no means independent of the morphology, physiology, and sexuality of the latter, and so the question of parasitism has to be studied in all its bearings, and various investigations to be carried on side by side to elucidate one another.

If the Universities can co-operate with the Imperial Mycologist, they can do so even better with the provincial Mycologists who are nearer in point of actual distance and therefore more easily accessible. I doubt, however, if there has been any serious co-operation between these and this is regrettable. The absence of this co-operation is doubtless mostly unintentional and due chiefly to the simple fact that either has been too absorbed in its own work to think of the other, but perhaps one could cite a case or two where suspicion or jealousy have prevented co-operation. We must sink our petty differences and work harmoniously for the common good of our country. Personal contacts between Indian Mycologists, professional and amateur, would go far to promote that good-will and develop that strong national, scientific outlook which are so essential to the spirit of co-operation.

The Indian Science Congress and the Indian Botanical Society have done much to bring and keep Indian Botanists together. I think the time has come when we might think of calling inter-provincial Mycological conferences. These could be bi- or triennial to begin with, and if they are a success we might after a few years, seriously contemplate an Empire Mycological Congress in India. Lastly, we want inter-university co-operation and this should be comparatively easy of achievement. Members of the various University Botanical departments in India, specializing in Mycology, can always arrange joint schemes of work. Furthermore, where the subject is suitable, a first-hand account of his work from some one engaged in fungus research, parasitological, morphological, or cytological work, would be of great value to the Botanical staff and students of a college or University, and Universities would do well to exchange and invite men for a short course of special lectures. In this connection I would urge upon University Professors all over India to bear in mind the desirability of having one or more Mycologists on their staffs. This can be kept in view when new appointments are made or when a member of the staff is going abroad for further study to Europe. Failing this, some one can be sent to the Imperial Agricultural Research Institute for a course in Mycology and Plant Pathology.

One or two other matters and I have done. Suitable books in Indian Mycology is one of our greatest needs. Butler's excellent book on fungi and disease in plants has so far been the only one of its kind and is still the chief text-book for the Indian student. Even this book is now out of print. Much work has been done since its publication and it is now up to the Mycologists in India to write another volume as good and useful but more up-to-date.

At its meeting in March last the Indian Universities' Conference recommended that the Imperial Research Institutes at Pusa and Muktesar might be affiliated to the Universities in India so that research work done at these institutes might in certain cases be recognized to enable a student to qualify for the Ph.D. or D.Sc. degree. Details would have to be worked out but the proposal is worthy of consideration.

In this huge country a central stock-culture-station would fill a very great need. The number of our investigators is rapidly increasing and there is a growing demand for authentic cultures. At present these are very difficult to procure, and workers and University laboratories are still often under the necessity of ordering cultures out from abroad. I think it would be in the fitness of things if Government came to our aid and established a fungus-culture station at the Imperial Agricultural Research Institute. It would have to be attached to the Mycological Section and could be maintained at very little extra expense if Government could agree to appoint one or two

capable assistants for the work. Part of the cost could be recovered by the price of the cultures which would have to be sold. The chief difficulty with regard to these cultures is that many of them cannot pass the hot summer months at room temperature in the plains and they are usually also ruined if kept inside a frigidaire. They can however be preserved at about 25°C. inside a cool incubator. This is doubtless expensive but the only other alternative is to send them up to the hills.

In conclusion, I must ask to be forgiven for presenting what I know to be a most imperfect review of the Mycological work done in India. Paucity of information in some cases and chiefly difficulties of time and space have conspired to make me omit reference to many a good piece of work which deserved mention.

Ladies and gentlemen, there is a great work for us to do and we must prove equal to the task because the future is full of promise.

Section of Botany.

Abstracts.

ALGÆ.

1. On *Chara benthamii* A. Br. and *Chara gymnopitys* A. Br.

B. C. KUNDU, Rajshahi.

Groves in his 'Notes on Indian Charophyta' in the *Journal of the Linnean Society*, Vol. XLVI, 1924, has united *C. benthamii* and *C. gymnopitys* and has formed only one species—*C. gymnopitys*, although Braun, the author of these two species, has kept them separate and described them separately. The difference between these two species lies in the number of stipulodes and branchlets, the former having the same number of each and the latter double as many stipulodes as branchlets. Groves has not been able to separate the two species satisfactorily by this character.

The writer of the present paper has collected specimens of both these species from various parts of Bengal and after careful observation and critical examination of specimens, specially of those collected from the district of Dinajpur, has come to the conclusion that the two species should be kept separate.

The two species have been described in detail and new points of difference besides the old ones, have been discussed.

2. On some noteworthy Charophytes from the district of Dinajpur, Bengal.

B. C. KUNDU, Rajshahi.

With the idea of publishing a monograph on the Charophytes of Bengal the author has been collecting specimens for the last few years from the different districts of Bengal. In the present paper he gives an account of some interesting forms belonging to the two genera—*Chara* and *Nitella* from the district of Dinajpur, Bengal.

3. Studies on the Myxophyceæ of Bengal—II.

J. C. BANERJI, Calcutta.

In this paper a systematic account of 20 species of filamentous blue-green algæ, collected from Lower Bengal, is given in detail. Some of the species are recorded for the first time from this province.

4. On some Myxophyceæ from Benares.

Y. BHARADWAJ, Benares.

The paper deals with a few out of a very large number of Myxophyceæ collected from Benares during the last several years. Twenty-one species are recorded, out of which seven are new species, three are new varieties, and four are new forms.

5. On two forms of *Hydrurus* Ag. collected from Kashmir.

Y. BHARADWAJ, Benares.

The paper describes two species of the algæ; one is *H. foetidus* (Vill.) Kirchn. and the other is a new species.

6. On a form of *Sphæroplea* Ag. collected from Kashmir.

Y. BHARADWAJ, Benares.

The paper deals with some interesting features in the morphology of the alga.

7. Notes on the occurrence of salt-water species of Algae in the river Hooghly.

K. BISWAS, Calcutta.

Two rare salt-water species of Algae which have evidently found their access during the high tide to the river Hooghly have been recorded. One of these is *Coscinodiscus radiatus*—a diatom of deep sea-water. Col. Seymour Sewell collected this particular diatom from the Indian Ocean, along with pellicles of sea-mud which on examination were found to be composed of rhizoidal portions of some sea-weeds. This alga has recently been gathered from the river both during high and low tide, with plankton nets fixed at different times during the day and at different portions of the river Hooghly in front of the Royal Botanic Garden, Calcutta. The other alga, determination of which has recently been confirmed by Dr. Lily Newton, and has been verified by her after comparison with specimens in the Natural History Museum is *Lomentaria articulata*, forma *angustior*. This specimen which closely resembles a plant obtained from Cherbourg, France, as stated by Dr. Newton, is rather interesting. The alga grows abundantly on bricks, stones, and other similar hard substrata within the tidal zones along the banks of the river Hooghly. The life-history of the plant is now being studied in detail.

8. Common Diatoms of the Loktak Lake, Manipur, Assam.

K. BISWAS, Calcutta.

This paper forms a continuation of the paper published by the writer in collaboration with Dr. P. Brühl, under the title of the 'Algae of the Loktak Lake,' *Mem. Asiat. Soc. Bengal*, 8, No. 5 (1926).

It may be mentioned that the floating islands of vegetation harbour a rich stock of Diatom flora—some of which are evidently the food of the fish—fauna of the lake. These common Diatoms have been worked out.

9. Preliminary observation of the association of algae and animals.

K. BISWAS, Calcutta.

The relation between algae and animals has been recognized by earlier biologists, but the exact nature of this association demands clarification. The association of algae and animals may be of simple association, or a symbiotic relation between the two, or algae supplying food to animals. Such relations of algae and animals are sometimes called *epizoic* or *endozoic* according to the different situation of the algae in an animal body. Investigations during the last twelve years have enabled the writer to gather sufficient materials from which true symbiotic relation between *Chlorella* or of related genera and a variety of unicellular and multicellular animals may be surmised. The relation between algae and animals has been traced up to man by some of the workers among whom L. H. Tiffany's name may be mentioned. Microphyto-plankton algae supply food to zooplankton organisms, which in their turn serve as food to various Crustacea such as Cyclops, Copepods, etc., which in their turn again supply food to larger Crustacea, and these again are devoured by smaller fishes, and on these again live our larger edible fishes. Thus there is a link between the

smallest unicellular algæ and the highest being Man. Sixty thousand Copepods were once recorded from the stomach contents of Herring and about 2,500 diatoms were discovered inside a copepod. Sometimes the distribution of the Nano-Plankton Algæ controls the distribution of fishes.

10. A collection of blue-green algæ growing on the shells of *Talia Intha* (Mollusca) from Inle Lake, Burma.

K. BISWAS, Calcutta.

The late Dr. Annundale, F.R.S., during his zoological expedition of the Inle Lake collected some Mollusca, the shells of which were found overgrown with several species of blue-green algæ. These epizoid algæ have been worked out by the writer.

11. Century of Bengal algæ.

K. BISWAS, Calcutta.

Valuable contributions on Bengal algæ have been made by some of the earlier algologists, such as Lagerheim, Royle, Martens, Wallich, Kurz, W. West and G. S. West. The writer in collaboration with Dr. P. Brühl has also made, in recent years, a number of contributions on the algæ of this Province. But considering the various climatic conditions prevalent in the presidency of Bengal ranging from the coldest to the fairly hot regions, Bengal presents ideal conditions for rich harvests of algæ. Extensive marshy spaces and innumerable numbers of tanks and *jheels* particularly in the Eastern Bengal, a large belt of sea-front in the district of Chittagong and estuarine areas in the Sundribuns harbour inexhaustible treasures of fresh water, brackish water and salt-water algæ. The inundated areas, the swamps, rice-fields etc., scattered all over the province are store-houses of vast accumulation of sweet water algæ. No systematic attempt has yet been made to study in detail such rich and varied types of algæ of this province in relation to their distribution and nature of growth at different habitats. Such a study will undoubtedly have considerable bearing upon the economic conditions of the country as well; as study of algæ is of very great importance to pisciculture in offering algal food to fishes, and to agriculture in supplying biological data of the soil of the rice fields. Descriptions and illustrations have been added to those species which have either not been recorded before or are insufficiently described.

12. The genus *Apiocystis* in the Punjab.

S. L. GHOSE, Lahore.

A species of *Apiocystis* has been discovered in a collection of algæ made by Mr. M. S. Randhawa from Hamira and Jhingran in March, 1930. The species resembles *Apiocystis Brauniana* Naeg. closely, but differs from it in the much larger size which the colony may attain and also in the shape of older colonies, which may become tuberculate or lobed. The very young colonies are epiphytic on species of *Spirogyra* and *Oedogonium*.

13. A systematic study of the genus *Oedogonium* of the Central Punjab.

S. L. GHOSE and PREM LAL, Lahore.

A collection of various species of *Oedogonium* was made during the period, October, 1933 to April, 1934. In this paper 18 species are described and figured. Out of these 2 species and 4 varieties are probably new.

14. A study of some Zygnemales of the Central Punjab with a note on the process of conjugation in Spirogyra.

S. L. GHOSE and K. S. KAZIM HUSSAIN, Lahore.

In this paper 14 species of *Spirogyra* and 2 species of *Zygnema* are described and figured. In addition, some observations on the conjugation of *Spirogyra* are recorded, the important ones of which are the following:—

- (a) Scalariform conjugation may take place between more than 3 filaments (*Sp. setiformis*, *Sp. jugalis*, *Sp. bellis*).
- (b) Zygotes are sometimes produced by the coalescence of 3 gametes (*Sp. neglecta*, *Sp. jugalis*).
- (c) All the contents of the physiologically male cell may not be used up in sygote formation; the remaining matter may either have chloroplasts in spiral condition or may round itself and develop a thick wall (*Sp. jugalis*, *Sp. setiformis*, *Sp. dubia*).

15. Diatom-flora of the Punjab Plains.

M. ABDUL MAJEED, Lahore.

A monograph on the subject has been prepared which contains a systematic study of the Diatoms inhabiting the soil, salt and fresh water from the Punjab Plains and some places near about it. The collection was made by Dr. S. L. Ghose and the author during the years 1931-34. Figures of all the species studied are described therein and a map showing nearly all the principal places from where the collections have been made is also given.

A detailed account of the occurrence and distribution of various species of Diatoms has also been added to this paper.

16. A collection of Freshwater Algæ from the Kulu and Lahul Hills.

M. ABDUL MAJEED, Lahore.

The material was collected during the months of July to September, 1933. The collection shows a large number of species of Algæ belonging to the genera *Chara*, *Cladophora*, *Chaetomorpha*, *Oedogonium*, *Spirogyra*, *Zygnema*, *Closterium*, *Cosmarium*, *Tolypothrix*, *Notochopsis*, *Palmodictyon*, *Euglena*, *Nostoc*, *Staurastrum*, *Melosira*, *Gymbella*, *Navicula*, *Synedra*, *Eunotia*, *Diatoma*, *Amphora*, *Gomphonema*, *Nitzschia* and *Gyrosigma*. It is worthy of mention that at two places (viz. Kalath and Bashist Kund) in a hot water sulphur spring only Myxophycean forms especially the species of *Oscillatoria* seem to flourish abundantly.

17. A note on Microspore-formation in some Centric Diatoms.

M. ABDUL MAJEED, Lahore.

Microspore-formation has been studied in some of the freshwater forms met with in Lahore and its vicinity especially in *Melosira Varians* Ag. at its natural habitats and also experiments have been performed to produce them culturally.

The study leads to the following interesting conclusions:—

Nature favours auxospore-formation in the Diatoms studied but artificial culture experiments produce microspores.

Besides Plankton-diatoms, others also produce microspores. (This is quite in agreement with Lemmermann's view.)

In freshwater Pennatæ auxospore-formation takes place to a greater extent than in Centricæ.

FUNGI.

18. A note on the variation of pores of *Polystictus xanthopus* Fr. and *Polystictus flabelliformis* Kl. at high altitudes.

S. R. BOSE, Calcutta.

Specimens of *Polystictus xanthopus* Fr. collected from high altitudes shows three kinds of porous areas—some with typical very small pores, some with much bigger pores, and others with distinct hydroid pores. In one piece of dead branch of a tree specimens with typical minute pores and hydroid pores were growing close to each other. Specimens of *Polystictus flabelliformis* Kl. at high altitudes similarly show two kinds of porous surface—some with typical very small pores and others with much bigger pores. Otherwise (i.e. morphologically and anatomically) in both the cases the specimens are exactly the same. It is concluded that they are variations of the same species. Usually we do not come across such variations in the plains where they are so common with very minute pores on the lower surface.

These specimens have been collected from high altitudes—Bhutan border and Lokra hills about 10,000 ft. elevation, and are shown in illustrations.

19. The distribution of *Polypores* at high altitudes.

S. R. BOSE, Calcutta.

The following six species of *Polypores*, mostly saprophytes, obtained from the Lokra hills, Assam, at 8,000 to 10,000 ft. elevation through the kindness of Dr. N. L. Bor, have never been found in the plains of Bengal but are very common in Europe and North America, i.e. north temperate region (the author collected them abundantly in forests round Paris and Berlin, and in England in 1924):—*Polyporus squamosus*, *P. sulphureus*, *P. gilvus* forma *lichnoides*, *Fomes fomentarius*, *Fomes pinicola*, and *Amaroderma (Fomes) rugosus*. As most of the plants of the high hills harbouring these species of *Polypores* as parasites or saprophytes do not grow in our plains, we do not come across these in the plains. This seems to confirm Dr. G. R. Bisby's remark (1933) that the distribution of fungi is primarily controlled by the distribution of host or substrata and that the climatic factors have no great effect here.

20. Interesting Fungi—I.

ANIL MITRA, Allahabad.

Mucor hiemalis (Zygosporic).—In January 1931, a mucor was found growing on soil in the University Botanical gardens. Careful examination revealed the presence of zygosporic which were very rare. Zygosporic cultures were secured and the two sexes separated. These when put against each other gave rise to lines of zygosporic of which various patterns were obtained. Best growth of the fungus was obtained on potato-glucose agar and next best growth on Brown's starch. Malt agar was the least favourable medium for its growth and malt agar with codliver oil was only slightly better than the last. The only other zygosporic mucor recorded in this country, so far as the writer is aware, is *Mucor recemosus*.

Allomyces arbuscula.—This fungus was first described by Butler in 1911 having obtained it from Pusa and Pooná. Probably it has not been found again in this country since then. The writer has been able to secure a culture of this fungus from a tank in the Botanical gardens, Allahabad. A fresh detailed study of it has been undertaken in the light of the discovery of a peculiar mode of sexual reproduction in the allied species *Allomyces javanicus* by Kniep.

Cyathus sp.—The Nidulariaceæ or Bird's nest Fungi though very common in the tropics have been rarely collected in India. The present specimen was collected by the writer in August, 1932, growing on a piece of wood at Allahabad and has been fully described.

21. Studies on the Indian aquatic Fungi.

ANIL MITRA, Allahabad.

For some time the writer has been engaged in morphological and physiological studies of some of the Indian aquatic fungi. Preparation of pure cultures and their maintenance has proved to be a task of considerable difficulty. The following fungi have been studied after isolation of pure cultures, some of them being obtained repeatedly in many collections from different localities—*Allomyces arbuscula*, *Pythium proliferum*, *Pythium aphanidermatum*, *Pythium* sp., *Achlya* sp., *Dictyuchus sterile*, and *Aphanomyces* sp.

22. Morphological and cultural studies in the genera *Vermicularia*, *Colletotrichum*, and *Gloeosporium*.

P. R. MEHTA, Allahabad.

A morphological study of a number of typical representatives of the genera *Vermicularia*, *Colletotrichum*, and *Gloeosporium* was made in the natural condition and in artificial culture. Incidentally it also included the physiology of the different strains including such well-known indigenous species as *Colletotrichum falcatum* Went, and *C. graminicolum* of whose cultural behaviour little is known. It is concluded that the criteria for classification of these genera, viz. the character of stroma—erumpent in *Vermicularia* and innate in *Colletotrichum*—the presence, the number, and the distribution of setæ are partly, if not entirely, controlled by environmental factors and are, therefore, of little systematic value.

23. Morphological and cultural studies of the genus *Acrothecium*.

P. R. MEHTA, Allahabad.

Acrothecium has been recorded on many hosts from India and elsewhere but so far only five species have been identified. The writer made a careful morphological, statistical, cultural, and physico-chemical study of a number of strains, chiefly from graminaceous hosts. On the basis of these comparisons it has been possible to distinguish a number of strains in otherwise morphologically alike forms. Also, some strains which were morphologically (and even statistically) slightly different proved similar in culture. After a careful consideration it is proposed that the limit of the conidial width of *Acrothecium lunatum* should be raised from 12 microns (as proposed by M. Mitra and supported by Mason) to 15 microns. This does not encroach on the specific distinctions of *A. penesitii* a distinct species also with three septa. The four septate strains have proved to be very distinct from the three septate strains, and it is proposed that they should be designated as *A. geniculatum* (Tracy and Earle) Tehon (= *A. falcatum* Tehon).

24. Polyporaceæ of the Central Provinces.

P. R. BHAGWAGAR, Allahabad.

A large collection of Polyporaceæ was made during monsoon in 1930 from Jubbulpore, Khawdwa and other neighbouring places of the Central Provinces. The author has studied most of these and their detailed structure has been investigated. They include a number of very rare

and interesting forms which were mainly collected from Jubbulpore of which the following deserve special mention :—

Polyporus indicus.

P. cuticularis.

Fomes pallidus Petch.

P. agariceus Berk.

Poria calcea (Fr.) Bres=

Poria vulgaris var. *calceator*.

Spongipellis stramineus Pat.=

Trametes straminea (Pat.)

Lloyd.

25. The effects of different fresh fruit juice media on certain strains of *Helminthosporium*.

P. R. BHAGWAGAR, Allahabad.

Six species of *Helminthosporium*, viz. *H. sacchari*; *H. rostratum* (A); *H. rostratum* (B) different strain; *H. tetramera*; *H. bambusa*; and *H. sp.* were grown on seven fresh fruit juice media to determine the effects of the latter on the growth of these fungi. Brown's synthetic medium with starch was used as the standard. The macroscopic cultural features of all the forms showed greatest development on grape juice agar and generally the second best development was seen on green mulberry agar. On the other hand poorest development was obtained on guava agar and papaya agar. Sporulation was best shown on Brown's starch synthetic medium which, as regards the development of other characters, however, lags behind most of the other natural fruit juice media. Saltations occurred in certain strains on certain media in the form of sectors or as isolated scattered patches of aerial mycelium. The saltants were found to differ in almost all the characters from their respective parents. After a careful consideration of the results obtained, the author recommends the media in the following decreasing order of suitability for the cultivation of the different strains of *Helminthosporium*—grape juice agar, green mulberry agar, apple agar, red mulberry agar, sweet lime agar, Brown's starch agar, guava agar, and papaya agar.

26. Studies in water moulds—Part I.

H. CHAUDHURI and P. L. KOCHHAR, Lahore.

Several species of *Saprolegnia*, *Protoachlya*, *Isoachlya*, *Achlya*, and a species of *Rhizidiomyces* have been isolated and described. A few are new forms. Growth characters and factors influencing sexual and asexual reproductions have been studied.

27. A contribution to our knowledge of the Indian coprophilous Fungi—Part II.

M. A. GINAI, Lahore.

The study of the coprophilous fungi is being continued under the direction of Dr. H. Chaudhuri. In the first part (*J.I.B.*, 1933) Mr. Mahju described 29 species belonging to 21 genera from six different dung. In this paper 38 more species belonging to 18 genera have been described, thus bringing the total to 67 species in 39 genera.

28. Simplification of spray methods in the control of diseases.

H. CHAUDHURI, Lahore.

Results of spraying on the control of aphids and sooty moulds, wither-tip, chlorosis and canker of citrus have been described.

29. A scheme for the dissemination of the knowledge of plant diseases in India.

H. CHAUDHURI, Lahore.

30. On some *Aspergilli* and *Penicilli*.

H. CHAUDHURI and MD. UMAR, Lahore.

20 species of *Aspergillus* and *Penicillium* have been isolated from different sources and grown in culture.

31. A study in physiology of *Aphanomyces levis*.

H. CHAUDHURI and S. A. MALLIK, Lahore.

It causes root-rot of pea. The causal organism was isolated from the soil of a potted plant. Growth characters under different physiological conditions have been described.

32. A disease of the mango plants due to *Gloeosporium* sp.

S. A. MALLIK, Lahore.

The causal organism has been isolated and inoculation experiments have been done proving its pathogenicity.

BRYOPHYTES.

33. Observations on the artificial germination of the *Cyathodium* spores.

N. K. TIWARY, Benares.

This paper embodies the results of experiments which were undertaken for comparison with the germinating stages found for the first time by the writer and reported to the Botany Section of the Indian Science Congress, Madras, 1929.

These experiments have brought to light a number of interesting points:—(1) The spores have an obligatory resting period. (2) In artificial cultures only the germ-tubes have been seen to develop, the rhizoids not at all being formed in a large percentage of the germinating spores. (3) When developed the rhizoids were not necessarily apoheliotropic; some continued to grow for a long time towards the incident light. (3) In all observed cases the spores invariably produced a germ-tube. The germ-disc was not produced at any stage. (5) The germ-tube sooner or later responded heliotropically to incident light.

PTERIDOPHYTES.

34. On the Benares Isoetes.

R. D. MISRA, Benares.

The paper deals with the morphology and anatomy of the various organs, revealing certain interesting features, of a form of *Isoetes* collected for the first time from Benares by Prof. Y. Bharadwaja in October, 1930.

35. On chromomere constitution of the meiotic chromosomes in *Osmunda javanica* Bl.

P. C. SARBADHIKARI, Colombo.

The material worked upon, *Osmunda*, tends to demonstrate a very great precision in the chromomere constitution of the meiotic chromosomes. To consider only the most important feature, the heterotype chromosomes, we find that at metaphase there are two pairs of chromosomes in the center of the plate, with four pairs of much larger ones arranged in radiating fashion around them. In some material it is easy to see that the metaphase chromosomes are organized internally into chromomeres, though these are somewhat irregularly arranged. Even before they separate the larger chromosomes show a cleft at the outer end opposite the fibre attachment. The smaller chromosomes are slow to split but finally do so. Consequently, there is at telophase a diploid number of separate chromosome halves. When the larger chromosomes separate in anaphase it is evident that in each half-chromosome there is a double row of rounded chromomeres. These are definite in number, well separated from each other and stain deeply in contrast to the almost colourless matrix. The chromomeres which enter the construction of the sperm nuclei seem to be already formed and merely awaiting the mechanical distribution of these mitoses.

36. Ferns and fern allies from Burma.

K. BISWAS, Calcutta.

Our knowledge of Burmese ferns is rather limited. Hooker's 'Species Filicum', Hooker's and Baker's 'Synopsis Filicum' and Beddome's 'Ferns of British India' are indeed valuable additions to our knowledge of Indian Ferns including Burma. These were published as far back as 1883, and since then many valuable works containing new species have been published and considerable changes have been effected in nomenclature in the light of International Rules of Botanical Nomenclature adopted first in Vienna Congress in 1905, and recently at the Fifth International Botanical Congress, Cambridge, in 1931. The writer in his paper has made an effort in giving short descriptions together with notes on their distribution and habitats of about 200 species of Fern and Fern-allies collected from different places of Burma and especially of those which he collected recently during his expeditions in South Burma.

37. A solenostelic *Lindsaya*.

P. MAHESHWARI and H. R. BHARGAVA, Agra.

Anatomically the genus *Lindsaya* is characterized by a special type of stele showing a dorsal island of phloem enclosed within the xylem. In October, 1933, one of the authors with his pupil collected a species of *Lindsaya* from Darjeeling which shows an undoubted solenostele, and the leaf-trace, though at first undivided, soon forks into twin strands.

This species has been identified as *L. cultrata* Sw. by the Director, Kew Botanic Gardens, and Prof. F. O. Bower.

It is interesting to note that the diameter of the stele is only 280 microns, which is much less than that of any other solenostelic species of *Lindsaya* or *Odontosoria*.

GYMNOSPERMS.

38. The life-history of *Ephedra foliata* Boiss.

P. MAHESHWARI, Agra.

This paper brings together the observations made by the author on the morphology of *Ephedra foliata* during the last four years. A part

of the material was collected from Chhanga Manga (Punjab), where the plant grows wild.

Male gametophyte.—The development follows the course described by Land (1904) for *E. trifurca*. At the time of shedding, the pollen grains have 2 prothallial cells, a tube nucleus, a stalk cell, and a body cell.

Female gametophyte.—There is a hypodermal archesporial cell which divides to form a primary wall cell and megaspore mother cell. The former and the cells of the nucellar epidermis undergo many divisions to form a number of wall layers. The tetrad of megaspores may be linear or T-shaped. The chalazal megaspore always functions and gives rise to the female gametophyte in the usual way. Usually three archegonia are present.

Embryo.—The fertilized egg divides to form eight free nuclei which surround themselves with cytoplasm. Some or all of these may germinate to give rise to embryos, but finally one gets ahead of the others which are suppressed. The mature embryo is dicotyledonous.

Several abnormalities are described and their significance is also discussed as far as possible.

39. Occurrence of diploid male gametophytes in *Ephedra gerardiana* Wall.

P. N. MEHRA.

The haploid chromosome number in *E. gerardiana* was reported to be 14 as studied from the division of the body nucleus in the male gametophytes during the germination of the pollen grains in artificial culture. (*Curr. Sc.*, July, 1934.)

Since then a few male gametophytes very much larger than the normal ones have been discovered in the cultures interspersed among the latter which show some interesting features. These former which may aptly be termed 'giant' male gametophytes measure on the average $80\mu \times 45\mu$ as against $65\mu \times 30\mu$ of the normal ones and are in bulk about twice the latter. Their percentage is very low, about a dozen in five hundred, which comes to about 2-3%. The most important thing is that they possess 28 chromosomes as shown during the division of the body nucleus. The formation of the male nuclei takes place in the usual way so that each male nucleus contains 28 chromosomes—the diploid number. They seem to originate from the fusion product of two pollen grains which fused in their early stages of development as shown by the fact that the writer actually observed under the microscope during the germination experiments the emergence of a 'giant' male gametophyte from the inside of a grain which from its outline was clearly the fusion product of two grains. Besides, 'twin-grains' showing various degrees of fusion have been observed in the species. The possible rôle these abnormal gametophytes are likely to play in nature has been discussed.

40. Structure of the chromosome in *Ephedra peduncularis* Boiss and *Ephedra gerardiana* Wall.

P. N. MEHRA.

The structure of the chromosome from the mid-prophase up to the telophase stage has been investigated in the male gametophytes of the two species during the mitotic division of their body nucleus to form the two male nuclei. Allen's fluid P.F.B. 15 has been found to be the best fixative for such a delicate study.

At the mid-prophase each chromosome possesses clearly a less chromatic matrix in which the chromatic element in the form of two spiral threads is embedded, each representing the daughter chromosome

that would separate at the following anaphase. In the chromosome at the metaphase plate stage, each of the two chromonemata in a chromosome is already split so that the chromosome is a tetrad with respect to the chromatic threads, in other words each chromosome possesses two pairs of chromatic filaments embedded in the less chromatic matrix. Just before the anaphasic separation, the less chromatic matrix splits lengthwise separating two daughter chromosomes each with two chromonemata which move towards the poles during anaphase. At anaphase therefore each chromosome possesses a less chromatic matrix in which are embedded two chromonemata. Frequently owing to their very close approximation and parallelism in the coils, their double nature is obscured and apparently a single spirally coiled thread is visible but in cases where the close juxtaposition of the coils is disturbed so that the coils of the two threads lie opposite one another, the quality is unmistakably observed. During the Tasement Polaire stage the chromosomes undergo a very great diminution in size, come close together but distinctly retaining their individuality and seem to give out a secretion which acting upon the substance of the fibres in that area transforms it into Karyolymph in which the chromosomes become embedded. At the telophase the chromosome appears to be apparently homogeneous showing with the present technique no differentiation into matrix and chromatic element.

ANGIOSPERMS.

41. Birds in relation to angiospermous flowers.

T. C. N. SINGH, Sabour.

Tecoma undulata Don. (Bignoniaceæ); medium sized tree; flowers (February to March) clustered in corymbose racemes and of orange-yellow colour; sugary juice secreted in great abundance by the nectary disc is efficiently held in the upwardly directed corolla-tube. The flowers are visited usually in the cool hours of the morning by *Sturnopastor capensis* Linn. and *Turdoides terricolor* Hodgs.

Woodfordia floribunda Salisb. (Lythraceæ): large shrub; the profusion of clusters of bright red flowers (February to April) gives it a very characteristic flaming appearance. Sugary juice is secreted by the nectary disc at the base of the corolla-tube. The flowers, as before, are abundantly visited by *Molpastes bengalensis* Blyth in the cool hours of morning.

None of these birds in either case have been found to make short-cuts to nectaries; nonetheless by their visitations they certainly promote pollination.

The biological adaptation of these birds to the respective flowers is discussed in the paper.

The observations herein recorded are in full accord and confirmation with the view of the author expressed some time back (*Journ. Indian Bot. Soc.*, XII, No. 1, 1933, pp. 65-68).

42. Studies in plant teratology.

B. C. KUNDU, Rajshahi.

In this paper the following abnormalities have been described:—

(1) Fasciation of the stems of *Mirabilis Jalapa*; (2) Tricarpellary pistil in *Calotropis gigantea*; (3) Occurrence of hermaphrodite flowers in *Carica Papaya*.

43. The embryosac development in *Capparis horrida* L.f.

S. HEDAYETULLAH, Calcutta.

The differentiation of the archesporial cell takes place in the hypodermis of the ovule, the funiculus remaining short and thick at this stage. As a rule there is no variation in the origin and mode of development of the archesporium. The megaspore mother cell becomes conspicuous by the enlargement of the archesporial cell. Both linear and T-shaped tetrads of four megaspores are formed at the result of two successive division of the megaspore mother cell. The chalazal megaspore functions, the other three megaspores degenerate. A normal eight-nucleate embryosac is developed from the functioning megaspore. The antipodals degenerate before fertilization.

44. The development of female gametophyte in *Moringa pterygosperma* Gaertn.

S. HEDAYETULLAH, Calcutta.

Single archesporial cell is differentiated three or more layers below the epidermis of the ovule. The development of this archesporial cell into a megaspore mother cell takes place quite late, when the bending of the funiculus and development of both the integuments have already proceeded to a considerable extent. Four megaspores are formed, mostly T-shaped, though linear tetrads are not uncommon. The inner megaspore is the functioning one. Eight-nucleate embryosacs of large size have been observed. Sometimes very early degeneration of the antipodals take place, thus giving the false impression of five-nucleate mature embryosac in this species.

45. The occurrence of *Kallostroemia maxima* Wight and Arn. in India.

S. HEDAYETULLAH, Calcutta.

This species was first noticed by the author in the year 1927 on the banks of the Salt lake, Dhapa Gate (Kudghata), Calcutta. It is still thriving there as an annual during the rainy season, but no progress in the direction of invading new areas is being made by it during these seven years.

A discussion of the geographical distribution and probable source of introduction of this species in the flora of India is undertaken.

46. Structure and division of meiotic chromosomes in *Narcissus*.

S. HEDAYETULLAH, Calcutta.

Dual intertwined chromonematic structure of the chromosomes during leptotene stage of meiosis has been traced from the early anaphase of the last premeiotic division of the nucleus.

During pairing (Zygotene) the quadruple structure is clearly evident due to progressive untwining of the intertwined chromonemata of each pairing univalent. Unlike somatic chromosomes this quadruple structure is due to the synaptic condition of the chromosomes, and not due to the cleavage of each chromonema of a chromosome.

From diakinesis to the telophase of the heterotypic division there is immense increase in the chromaticity of the chromosomes, consequently the finer structures of the chromosomes are not clearly discernable. In the prophase threads of the homotypic division, chromonematic structure of the chromosomes is again evident, the division of them taking place in the very late prophase or metaphase; thus the dual chromonematic organization of the chromosomes is maintained during the whole cycle of meiosis.

At certain stages in the cycle of chromosome development chromomeric condition of the chromonema is also observed.

47. Some important medicinal plants of Calcutta.

H. L. CHAKRAVORTY, Calcutta.

The need of a paper on medicinal plants of Calcutta and its Suburbs was keenly felt by the people of the locality. While investigating the medicinal plants of India as an assistant to Lt.-Col. R. N. Chopra, I.M.S., the author has attempted to make a list of the medicinal plants of the locality. Here the writer has endeavoured to point out the most important medicinal properties of these plants and their local uses. Their distribution, diagnostic characters and active principles have also been described. The vernacular names have been given.

48. Extranuptial nectaries on the leaf of Cucurbitaceæ.

H. L. CHAKRAVORTY, Calcutta.

For the investigation of general morphology and physiological anatomy of the glands on the leaf of Cucurbitaceæ the following species have been studied:—(i) *Cephalandra indica* Naud. (ii) *Cucurbita pepo* DC. (iii) *Lagenaria vulgaris* Seringe. (iv) *Luffa acutangula* Roxb. (v) *Luffa aegyptiaca* Mill.

The extra-floral or extranuptial nectaries in all the species except *Lagenaria vulgaris* arise from the lower surface of the leaf. In *Cephalandra indica* they are semi-circular or semi-lunar in shape, with the convex sides lying away from the lower epidermis and their flat surfaces either continuous with the lower epidermis or slightly depressed. The gland is surrounded by a layer of suberized thick-walled cells (superficial cells) except on the epidermal side, and the superficial cells are surrounded by tracheidal patches. Extrafloral nectaries of *Luffa acutangula* and *aegyptiaca* are more or less similar: unlike *Cephalandra indica* they are (i) smaller in size, (ii) protrude outwards from the general level of the epidermal surface, and (iii) the superficial cells are surrounded by irregular patches of tracheids. In *Cucurbita pepo* the nectaries are club-shaped and arise from the veinlets of the lower surface of the leaf. The centre of the apex of this elongated nectar-gland is depressed inward and like the former species a suberized layer of superficial cells is present. The tracheids approach nearer the superficial cells. In *Lagenaria vulgaris* two lateral glands arise from the petiole at the base of the leaf and a few glands are present at the vein-ends. In a R.T.S. the gland shows (i) thin-walled epidermal cells, (ii) prominent suberized superficial cells—wavy to irregular in appearance, (iii) a number of enlarged wavy parenchymatous cells in touch with the tracheids surrounding the superficial cells.

The writer has elucidated a few points regarding the secretion of sugary solution from the extrafloral nectaries from physiological point of view.

49. Cystoliths in *Momordica*.

H. L. CHAKRAVORTY, Calcutta.

For the present, the study is based on three species of *Momordica*, *Momordica charantia* Linn. *Momordica cochinchinensis* Spreng. *Momordica dioica* Roxb.

Penzig in 1881, first observed the presence of cystoliths in *M. charantia* and *M. echinata* Muhl. (= *Echinocystis lobata*). His observation of the occurrence of cystoliths in the lower epidermal cells of *M. charantia* have been verified by the author. The writer does not agree with Penzig in having crystals mostly present in groups of 3-5; in the

specimens examined by the writer, about 60% of the cystoliths are found present in groups of 2. The maximum number of cystoliths found inside an epidermal cell is 7.

The cystoliths in all the three species are uniformly scattered all over the lower surface of the leaf. They are encased inside an enlarged (sometimes ten times bigger than ordinary epidermal cell) epidermal cell. In *M. charantia* the cystoliths are more or less regular and arranged round a common centre from which each group is attached with a very short stalk. On chemical examination the cystoliths are found to consist of calcium carbonate in the form of globules deposited on a cellulose skeleton. They are unbranched. The skeleton shows concentric stratification.

The cystoliths in *Momordica cochinchinensis* have not been observed by any previous worker. They are arranged in groups of 2-4. Groups of more than four are not met with. They are symmetrically distributed all over the lower surface of the leaf.

The cystoliths in *M. cochinchinensis* are branched, irregular and hence heteroplanous. In the beginning these cystolith groups are more or less regular like those in *M. charantia*, but as they grow up they invariably branch and show the specified irregular arrangement. Due to this irregularity they show diversified appearance. Calcium carbonate is impregnated over a stratified branched cellulose skeleton. They are sessile or very shortly stalked. The number of cystoliths in a sq. cm. varies from 1,000-16,000 and in an entire leaf there may be as many as 1,00,000 cystoliths approximately.

The cystoliths in the leaves of *M. dioica* are more or less similar to *M. charantia*, the only difference being that the groups are slightly irregular.

Measurements of cystoliths: 60-75 μ in length; 35-42 μ in breadth. Breadth of the point of contact (stalk) 12-14 μ .

50. *Desmotrichum* Bl., its generic status and its affinity to *Dendrobium* Swartz, with a discussion on the synonymy of *Dendrobium macraei* Lindl. and *Desmotrichum fimbriatum* Bl.

V. NARAYANASWAMI, Calcutta.

In some of the recently published Indian Floras, *Desmotrichum* Bl., a hitherto obsolete genus, has been given prominence and described as a valid genus, under which *Dendrobium macraei* Lindl. has been reduced to a synonym of *Desmotrichum fimbriatum* Bl. This change is apparently a copy from Das Pflanzenreich, where Orchideae have been monographed. Critical examination of the specimens of these species in the Sibpur herbarium and a study of the literature bearing on the question, has led the author to differ considerably from the above conclusions. The author has shown in this paper that *Desmotrichum* Bl. has no definite status of its own as a valid genus, that *Dendrobium macraei* Lindl. is a true Indian species and quite different from the Malayan species of *Desmotrichum fimbriatum* Bl., which should be named as *Dendrobium plicatile* Lindl. The paper is illustrated.

51. On the recent changes in the specific names of Indian flowering plants, especially of certain well-known species.

V. NARAYANASWAMI, Calcutta.

The recent changes of specific names of several well-known Indian flowering plants, such as *Bombax malabaricum* into *Bombax ceiba*, *Eriodendron anfractuosum* into *Ceiba pentandra*, *Poinciana regia* into *Delonix regia*, *Peltophorum ferugineum* into *Peltophorum inerme*, and a number of

others, have been more annoying rather than puzzling to many in India, especially to the more conservative workers in the forest department. The author has herein attempted to prepare a list of the revised names of Indian flowering plants for the guidance of Indian botanists.

52. A preliminary note on *Cassia javanica* L. and *Cassia nodosa* Ham.

V. NARAYANASWAMI, Calcutta.

Externally these two species of ornamental flowering plants are so much alike that unless each is closely examined, it is impossible to distinguish one from the other. Further natural hybridisation takes place so freely in these two species that at times it baffles even a critical eye to isolate one from the other. The difficulty of identifying correctly the two species in the herbarium is further enhanced by the admixture of many horticultural forms which gradually grade one into the other. *Cassia javanica* L. is the older of the two, but Linneaus' observations that it is indigenous to India is not corroborated, because there has not been a single instance of this species occurring wild in India. *Cassia nodosa* Ham. has been described and figured by Roxburgh in his *Flora Indica* and in the *Icones*. But there are discrepancies between his drawings and his descriptions, because he has interchanged one with the other. From a study of the morphological characters, the author has attempted to delimit the species definitely.

53. Preliminary revision of the Gramineæ of India.

V. NARAYANASWAMI, Calcutta.

Drastic changes have taken place very recently in the nomenclature of Indian Gramineæ and several well-known genera have been surprisingly cut down to mere insignificance. In several of the recently published Indian Floras, such as the 'Botany of Bihar and Orissa' and the 'Flora of Bombay', these revised names have been incorporated, which has supplied the needs of the local botanists only. But the needs of the whole of India will not be met with unless the family of Gramineæ in Hooker's *Flora of British India* is also revised simultaneously.

The changes not only include the specific names, but also cover the distribution of the genera into groups and sub-groups. The genera of British India which have been subdivided and reallocated into other genera are *Paspalum*, *Panicum*, *Axonopus*, *Pennisetum*, *Tragus*, *Zoysia*, *Pollinia*, *Erianthus*, *Saccharum*, *Rotibœllia*, *Andropogon*, and *Anihistiria*. Many of the cultivated cereals, fodders, and oil grasses have been renamed in the light of recent advances. When we realize the importance of grasses as the chief fodder yielding family of plants, a knowledge of the correct nomenclature and the affinities of the several genera and species comprising the family of grasses becomes imperative. This preliminary revision is intended more as a guide than as an exhaustive monograph of the family. In this the author has followed Dr. Otto Stapf, a great authority on the group, and has revised the names in the light of recent works.

54. Revision of the Indo-Malayan species of *Glycosmis* Correa.

V. NARAYANASWAMI, Calcutta.

The Genus *Glycosmis* was created in 1805 by Correa De Serra from *Limonia pentaphylla* Retz, which became *G. pentaphylla* (Retz) Corr. This was considered one of the most protean species of the genus by almost all the systematic botanists of the world from Prof. Oliver, who first worked at it, down to very recent times. In the *Flora of British India*, Oliver's

varieties were repeated almost verbatim with three other additional species, namely *G. bilocularis*, *G. Sapindoides*, and *G. puberula*. While working out certain East-Himalayan and Assam specimens of *Glycosmis*, the author found it impossible to fit them in any of Prof. Oliver's varieties of *G. pentaphylla*. Therefore the sheets of *Glycosmis* from the Dehradun and Shillong herbaria were requisitioned, which together with the large collections of the genus in the Sibpur herbarium enabled the author to revise the genus thoroughly. This critical examination of a large suite of specimens has yielded very interesting results, which are incorporated in this paper. The once protean species of *G. pentaphylla* and its forms have yielded several clearly definable species each one being confined to definite geographical areas in India and elsewhere.

The following 24 species, of which 7 are new to science, are described in this paper with illustrations along with their distribution in India and outside. They are *G. pentaphylla* Correa., *G. arborea* Corr., *G. cymosa* (Kz) Nov. Comb., *G. puberula* Lindl., *G. pilosus* Nov. Sp., *G. monticola* Ridl., *G. chlorosperma* Spr., *G. macrocarpa* Wt., *G. Boreana* Nov. Sp., *G. paraphyllianis* Nov. Sp., *G. mansiana* Nov. Sp., *G. macrophylla* Lindl., *G. Parkeri* Nov. Sp., *G. Parkinsoni* Tanaka., *G. sapindoides* Lindl., *G. pseudo-sapindoides* Nov. Sp., *G. perakensis* Nov. Sp., *G. lanceolata* Spr., *G. crassifolia* Ridl., *G. angustifolia* Lindl., *G. bilocularis* Thw., *G. tomentella* Ridl., *G. rupestris* Ridl., and *G. elata*.

55. Three rare exotics of Mymensingh.

H. K. BHATTACHARYA, Mymensingh.

In the district of Mymensingh, many exotic plants of various types are found to grow. Some of them, though recently introduced, have already attracted attention by their rapid multiplication. But this is not the case with all other exotics. *Ophioglossum vulgatum*, *Hibiscus fragrans*, and *Lobelia radicans* are the three exotics, introduced here from the neighbouring divisions of East Bengal. Their multiplication is very slow and consequently they are very rare.

Localities of *Ophioglossum vulgatum*, as mentioned in 'Bengal Plants' and 'Ferns of British India' are Chota Nagpur, Sikkim, and Darjeeling. Its terrestrial life is unfavourable for its rapid distribution. Leaves of this fern have nothing attractive in them, so there is no reason for its cultivation. But it is reported to be a medicinal plant.

Localities of *Hibiscus fragrans* as mentioned in 'Flora of British India' are Sylhet, Cachar, and Assam. It is not mentioned in 'Bengal Plants'. Its flowers are sweet scented and seeds are covered over with brown hairs. Only one plant is present in a particular jungle. Fruits are rarely produced. Only possible means of propagation is by cuttings.

Lobelia radicans is another exotic of Mymensingh with a very limited distribution. Its localities as mentioned in 'Bengal Plants' and 'Flora of British India' are Khasi hills, Chota Nagpur, and places near about Ranchi.

56. The development of the embryo-sac and embryo in *Crotalaria juncea* L.

K. K. SAMAL, Calcutta.

A single archesporial cell differentiates in the third layer of the nucellus. It either directly acts as a megaspore mother cell or cuts off a parietal cell before doing so. An oblique 'T-shaped' tetrad of megaspores are formed, the chalazal one being functional. The mature embryo-sac is of the normal angiospermic type.

The fertilized egg divides into an apical and a basal cell by a transverse wall. The apical cell by further growth forms the embryo

while the basal cell gives rise to three cells arranged in a row, of which the second one from the top gives rise to the suspensor. The suspensor is massive and haustorial. It attains full development before the cotyledons are differentiated. The cotyledons are leafy.

57. Microsporogenesis in *Crotalaria juncea* L.

K. K. SAMAL and I. BANERJI, Calcutta.

The resting nucleus of the pollen mother cell shows a granular zone along the peripheral region. The spireme remains granular during the leptonema and synizetic stages. Brochonema loops are equal to the haploid number of chromosomes. The method of chromosome conjugation appears to be telosynaptic. The haploid number of chromosomes is eight. In late diakinesis the components of each gemini contract, leaving a hyaline connection at their point of union. Homotypic split in the chromosomes is first noted during heterotypic telophase. The homotypic division is normal. Cytokinesis takes place by furrowing. The mature, pollen grains are uninucleate.

58. Embryology of *Arachis hypogea* L.

I. BANERJI, Calcutta.

The archesporial cell differentiates in the third layer of the nucellus. It directly functions as the megaspore mother cell. The megaspore mother cell increases in size before reduction division. A normal linear tetrad is produced of which the chalazal macropore always develops and the rest degenerate. The mature embryo-sac contains eight nuclei and numerous starch grains. The synergids have pointed ends, and conspicuous vacuoles at the base. The egg is placed between the synergids and close to the primary endosperm nucleus. The antipodals degenerate before fertilization.

The endosperm nucleus divides before the first division of the fertilized egg. It soon forms a delicate lining for the entire embryo-sac. The development of the endosperm is of the nuclear type.

The fertilized egg divides by a periclinal wall. Further divisions appear to be in three planes. At an early stage in the development of the embryo, the embryo-forming region is sharply differentiated from the suspensor region. The top of the suspensor later on becomes sagittate.

59. Botanical tour in the North-Eastern Bengal extending up to the borders of Bhootan.

K. BISWAS, Calcutta.

During February to March, 1933, the writer undertook a botanical excursion up to the borders of Bhootan via the famous Madhupur jungle area of Mymensingh. This tour is in connection with his writing out a new flora of Bengal. He passed through more or less unexplored areas of Terai forests from Rajabhatkhawa, Raimatong and Buxa-duars. In marching through the Terai forests up to Buxa-duars he had to pass through dense savannah formation, subtropical areas and finally sub-temperate flora at an altitude of 6,000 ft. along the Bhootan frontiers. About 2,000 specimens have been collected. Some of them have not yet been recorded and interesting associations of plants in the unexplored areas and reserve forest areas have been studied.

60. Preliminary observation on the vegetation of the Naga Hills and Manipur.

K. BISWAS, Calcutta.

The writer and Mr. S. N. Bal, Curator, Industrial Section of the Indian Museum, undertook a joint botanical tour in some of the unfrequented areas of the Naga Hills and Manipur. Although a fairly good amount of collection has been made by the Assam foresters, yet not much attempt has been made to study the specific distribution of plants in such areas as the forest of Japvo hill ranges and other hill ranges and also of the Loktak lake in Manipur and the area merging in the borders of Burma. About 2,500 specimens have altogether been collected. Mr. Bal paid special attention to make a detailed note on the economic species available in this locality. Associations of plants have been studied in different areas and this will be illustrated by means of lantern slides. Dr. N. L. Bor's collections from this area, worked out by the writer, have also been appended to this paper. This paper, therefore, forms a complete record of the plants of this area up-to-date.

61. Notes on the systematic position of *Ficus Krishnii*.

K. BISWAS, Calcutta.

Interesting variation has been noted, as mentioned by the writer in his note in 'Nature' under bud mutation of *Ficus Krishnii*. This particular variation, namely reversion of a portion of the same branch to its supposed parent—*Ficus bengalensis*—seems to have considerable bearing on the systematic position of this species—*Ficus Krishnii*. In the present paper the writer discusses the systematic position of this species and suggests that *Ficus Krishnii* should be considered a horticultural variety of *Ficus bengalensis*.

62. Botanical collection in the Sikkim Himalayas.

MRS. A. CRAKER, H. P. NASKAR, and K. BISWAS,
Calcutta.

Not much collection has recently been received at the Calcutta herbarium from higher altitudes of the Sikkim Himalayas. Sporadic collections were received from the Secretary, Sikkim Raj, now and then which contained some interesting specimens of Primulas which, however, proved to be all old species as determined by Sir W. W. Smith. Opportunities, therefore, have been taken to get a more or less representative collection in and about Sikkim utilizing valuable co-operation of Mrs. A. Craker. Mrs. Craker accompanied by one of the Herbarium Assistants, Hari Pado Naskar, collected up to 18,000 ft. altitude and brought back about 800—phanerogamic specimens. Some of her high altitude algae and fungi are also of considerable interest.

63. A note on the distribution of *Gloriosa superba* Linn.
(Vern.: *Bachnag*, *Kulkhari*, *Bisha*, etc.) towards
Vikarabad.

M. SAYEEDUDDIN and M. ABDUS SALAM,
Hyderabad, Deccan.

Last summer while ascertaining the distribution of *Lantana camara* Linn. towards Vikarabad (a distance of about 52 miles from the Hyderabad City) *Gloriosa superba* Linn. was found growing only at one spot towards this side in a striking association consisting of *Lantana*, *Gymnosporia montana*, *Butea frondosa*, *Tectona grandis*, and *Dodonaea viscosa*. As this

was the only definite record of its occurrence towards this side it was mentioned in our article 'On the distribution of *Lantana camara* towards Vikarabad' published in 'Current Science'.

But our preliminary survey of the Vikarabad vegetation during the rainy season which was carried out recently revealed the gradual spread of *Gloriosa superba* and again its interesting association particularly with *Gymnosporia montana*. In the paper exact places of its occurrence, its probable course of spreading, and its useful medicinal properties have been mentioned.

64. A brief report of the preliminary survey of the vegetation of Vikarabad and its neighbourhood.

M. SAYEEDUDDIN and M. ABDUS SALAM,
Hyderabad, Deccan.

Vikarabad is only about 52 miles from the Hyderabad City, but the interesting and useful vegetation which it presents is worthy of careful survey. The soil for the most part of this distance is coarse and fine 'morum', but near Vikarabad it is replaced by red soil, rich in iron. There is a hill known as 'Anant Giri' about 2 miles from the Vikarabad village which abounds in luxuriant vegetation, and it was here that a lot of material was collected. The paper details the results of our preliminary survey of the vegetation of Vikarabad and its neighbourhood with special reference to its ecology. Altogether 88 species belonging to the 37 families have been mentioned.

65. Some new or little known plants from parts of Eastern Rajputana and Upper Gangetic Plain.

P. MAHESHWARI, Agra.

The following plants collected from Agra, Bharatpur, and Jaipur are not given in Duthie's Flora of the Upper Gangetic Plain, although all three places are included within the area of this flora :—

Psammogeton biternatum Edgw. (Umbelliferae). Agra. The first specimens of this were collected by a pupil of the author. *Limnophyton obtusifolium* Miq. (Alismaceae). Very common at Bharatpur in marshes. *Pedaliurus murex* L. (Pedaliaceae). Jaipur and Agra. *Sericostoma pauciflorum* Stocks. (Boraginaceae). Very common at Jaipur. *Verbesina encelioides* Bth. and Hk. (Compositae). Jaipur.

66. The presence of inter-xylary phloem in the stem of *Leptadenia spartium* R.Br.

P. MAHESHWARI, Agra.

The occurrence of *intra-xylary* phloem is a well-known phenomenon in several families of the Dicotyledons, but the presence of *inter-xylary* phloem is rare. While examining some sections of *Leptadenia spartium* (Asclepiadaceae), prepared by his postgraduate students, the author came across 'islands' of phloem lying within the secondary xylem in older regions of the stem. Further study revealed that this is caused by the fact that the cambium, besides cutting off secondary phloem on the outer side, also gives rise on its inner side to isolated strands of sieve tubes accompanied by parenchyma. These intra-cambial masses of phloem later become imbedded in the xylem.

The stem of this plant has, therefore, three phloem regions :—(1) outer normal phloem; (2) intra-xylary phloem adjoining the pith; and (3) inter-xylary phloem forming islands within the secondary xylem.

67. Anomalous secondary growth in the stem of *Tiliacora racemosa* Colebr.

P. MAHESHWARI, Agra.

A transverse section of an old stem of *Tiliacora* shows the presence of several concentric rings of vascular bundles separated by stone cells. These rings may be either complete or partial, the latter condition being due to eccentricity in growth. A study of younger material indicates that the activity of the normal cambium of the first formed ring of bundles ceases after a time and a new and extrafascicular meristem arises in the inner layers of the cortex. This process is repeated after some time and an old piece may show more than half a dozen supernumerary rings of normally oriented vascular bundles. So far as the author knows, such a behaviour is being described here for the first time in this genus.

68. A contribution to the morphology and cytology of *Tamarindus indica* L.

A. K. PAUL, Pusa.

The inflorescence is of the racemose type and consists of 5-35 flowers.

A high percentage of shedding has been noticed in flowers but rarely in flower buds or in young fruits.

The development of two of the staminodes into petals has been recorded for the first time. This has been suggested as a process of reversion.

The two integuments of the ovule originate almost simultaneously. The mature embryo-sac is completely covered by the two integuments of which the outer overlaps the inner.

The archesporial cell differentiates in the third layer of the nucellar tissue. More than one archesporial cells have been recorded.

Division of the archesporial cell into a wall cell and the megaspore mother cell is noticed.

Embryo-sac development is normal. Dyad cells are dissimilar. The origin of the 'Scilla type' of embryo-sac development from the 'Normal type' has been discussed.

The mature embryo-sac is normal. The fusion of polar nuclei takes place before fertilization. The antipodals persist till anthesis. Filiform apparatus is absent in the synergids.

A nucleolar protuberance from leptoneuma to diakinesis is commonly observed during meiosis. Similar protuberances have also been observed in some of the tapetal nuclei.

A parasynaptic mode of chromosome conjugation and the disappearance of the nucleolus by fragmentation have been described.

Extrusion of chromatic bodies from the microspore nuclei to the surrounding cytoplasm is a characteristic feature.

Cytokinesis takes place by 'furrowing'.

Division of the nuclei of the tapetal cells in the microsporangium is followed by non-formation of partition walls. Two- to six-nucleate tapetal cells are of common occurrence.

The haploid chromosome number has been determined to be twelve and the diploid number to be twenty-four.

69. The development of the male gametophyte of *Mollugo nudicaulis* Lamk.

H. R. BHARGAVA, Agra.

The anther shows the usual structure. There are three wall layers below the epidermis,—an endothecium, a middle layer, and the tapetum

The middle layer degenerates very early. The tapetal cells become binucleate through mitotic divisions. The divisions of the microspore mother cells are simultaneous and both tetrahedral and isobilateral types of tetrads are formed but the latter type is rare. On division of the microspore nucleus a large tube cell and a small crescent shaped generative cell are formed. The nucleus of the latter divides again so that the mature pollen grain is three-nucleate. The two male nuclei become slightly elongated. The tube nucleus begins to show signs of degeneration rather early.

Pollen grains have also been found to germinate inside the loculus and the pollen tubes were as long as 26 microns. There are usually three and rarely four germ pores in each pollen grain.

70. The development of the male gametophyte in *Moringa oleifera* Lamk.

VISHWAMBHAR PURI, Agra.

Although the young anther is four lobed, sporogenous tissue is developed only at two corners, and is distinguishable only when two or three wall layers have been cut off. In older anthers up to a dozen wall layers are present. Most of the tapetal cells remain uni-nucleate.

The microspore mother cells on reduction form tetrads which may be either tetrahedral or isobilateral. Cytokinesis takes place by furrowing. The microspore nucleus divides into the tube and generative nuclei which become separated by an ephemeral plasma membrane. The generative nucleus divides while the pollen grains are still in the anther. The mature grains are thus tri-nucleate and have four germ pores. In dry condition the pollen grain is oblong-ovoid and carries a fold from one point to the other.

In some cases the pollen grains had begun to germinate while still within the anther, though the tubes were very short. The muggy weather in the first week of March, 1934, was seen to provide favourable condition for such germination and the pollen tubes became very long.

71. Embryo-sac development in *Berberis nepalensis* Spreng.

B. M. JOHRI, Agra.

There are four to five anatropous ovules in the ovary and each ovule has two integuments. The megaspore mother cell divides to produce a linear tetrad of four megaspores of which the lowest functions. Further development is quite normal and an eight-nucleate embryo-sac is produced in the usual way. The synergids are ephemeral and soon degenerate. The polar nuclei meet early in the middle of the embryo-sac but do not seem to fuse for a long time. The antipodal cells are very conspicuous and occupy a fairly large area.

72. A note on the gametophytes of *Cuscuta reflexa* Roxb.

B. M. JOHRI, Agra.

Microsporogenesis and male gametophyte.—The young anther shows a group of microspore mother cells surrounded by a tapetum, a single ephemeral middle layer and an endothecium. The divisions of the mother cells are simultaneous and their walls become mucilaginous during tetrad formation. The intine and exine are very well distinguishable even in young microspores. The pollen grains are bi-nucleate at the time of shedding.

Megasporogenesis and female gametophyte.—Normally there is a single hypodermal archesporial cell but sometimes there are two lying

side by side. The archesporial cell directly functions as the megaspore mother cell and divides to produce two cells of which the upper is smaller and soon degenerates. The nucleus of the lower cell divides thrice and produces a normal eight-nucleate embryo-sac. The development is thus of the '*Scilla type*'. The nucellus is much reduced and soon disorganizes so that the gametophyte is directly surrounded by the single massive integument. The antipodal cells are ephemeral.

73. The life-history of *Neptunia oleracea* Lour.

BAHADUR SINGH and T. N. SHIVAPURI, Agra.

The inflorescence is a globose head of about 50 flowers divisible into three regions :—(a) The lower region, with flowers having antherless filaments and without a pistil, (b) the middle or transitional region, having flowers with staminodes and a rudimentary pistillode a little higher up, (c) and the upper region, with hermaphrodite flowers having the usual Mimosean characters.

Microsporogenesis and male gametophyte.—There are four wall layers including the tapetum which remains uni-nucleate. The divisions of the mother cells are simultaneous and the microspores are usually arranged tetrahedrally. Quadripartition of the mother cell is by vacuolation and furrowing. The pollen grains are bi-nucleate at the time of shedding.

Megasporogenesis and female gametophyte.—There is a single hypodermal archesporial cell which divides into the primary wall cell and megaspore mother cell. The primary wall cell divides periclinally and anticlinally to form a number of wall layers. A linear tetrad of megaspores is formed of which the chalazal gives rise to a typical eight-nucleate embryo-sac. The antipodal cells disintegrate early and the synergids are rather ephemeral. The endosperm is free nuclear and the mature embryo is dicotyledonous.

74. The female gametophyte of *Melia azadirachta* Linn.

BAHADUR SINGH, Agra.

The ovary is trilobular below with two ovules in each loculus. Higher up it becomes unilobular, and as it approaches the style, it once again becomes trilobular. The ovules are anatropous with two integuments and the micropyle is turned upwards.

The megaspore mother cell becomes very deep seated on account of the repeated divisions of the epidermis and the primary wall cell. There is a linear tetrad of megaspores of the usual type and the chalazal megaspore forms a normal eight-nucleate embryo-sac. In some cases the micropylar megaspore also grows for sometime and sometimes all the four megaspores degenerate. The antipodals are rather ephemeral and synergids are large. Degeneration in the embryo-sac is very common. The endosperm is free nuclear and no trace of it is left when the embryo is mature.

75. Observations on the somatic chromosomes of *Urginea indica* Kunth.

T. S. RAGHAVAN, Annamalainagar.

The diploid chromosome number is twenty. The complement is resolved into four types on the basis of size, and the chromosomes exhibit 'somatic pairing'. All of them are characterized by constrictions of the closely subterminal type. Of the five pairs of intermediate sized chromosomes, one pair (C_1) has a secondary constriction at its distal end resembling a satellite, while another pair (C_2) has the segment beyond the subterminal constriction reduced to a minute structure. Triploidy has been recorded

in some individuals. Details of somatic mitosis have been worked out and some light thrown upon the nature of the anaphase chromosomes which appear to be single cylindrical hollow structures. The characteristic nucleolar behaviour of the species is fragmentation prior to disintegration.

76. Secondary growth in monocotyledons—I.

G. P. MAZUMDAR, Calcutta.

Secondary growth in thickness has been observed in the following species:—

Zingiberaceæ .. In the rhizomes of *Curcuma amada*,
Curcuma longa, *Zingiber officinale*.

77. Setting of seeds in *Hibiscus rosa-sinensis*.

G. P. MAZUMDAR, Calcutta.

The setting of seeds in only two varieties of this plant was noticed for the first time by the author in 1932, and since then every year in these plants growing in his garden and in that of his neighbour. In the last session of the Congress, Prof. Kundu reported its occurrence from Rajshahi.

Setting of seeds, in almost all flowers, has been observed to commence in winter just after the rains, and to continue till the beginning of the next rains. Flowers are visited by sun-birds but they seem to have nothing to do with pollination. Butterflies are often seen to visit these flowers. Non-setting of seeds during rains appears to be due to the accumulation of rain water in the calyx-cup—a factor causing an early rotting of the ovary which falls off in about a couple of days.

The embryo-sac is perfectly normal in its development with a normal egg-apparatus (cf. Misra, *Proc. Ind. Sc. Cong.*, 1931, p. 276) though Mr. Selim Ali and Prof. Tewari report otherwise [*Journ. Bom. Nat. Hist. Soc.*, V (1933), p. 580]. The antipodal cells disorganize before fertilization. The nucleus of the egg is comparatively small. Plants reared from seeds are growing in the Presidency College garden.

78. Two peculiar cases of monstrosity.

H. K. DATTA, Dacca.

Water-lily (*Nymphaea lotus*).—A flower of *Nymphaea lotus* was collected by my bearer, the like of which has not been observed before. The flower has no stamens and carpels. The upper part of the thalamus bears three young leaves with involute ptyxis. One of the leaves bears a flower-bud in its axil. Six more petiolate flowers are borne in the axils of the petals of the parent-flower. Of these six, two are fused together sideways by their petioles and receptacles. All these seven daughter-flowers are complete and perfect.

Rose (*Rosa indica*).—The flower has no stamens and carpels. The thalamus is like an elongated stem. The sepals are spirally arranged, instead of being arranged in a whorl, as in ordinary flowers. A few bracteoles also are present. Near the apex of the flower, there is an ordinary compound leaf; above that are a few petals. The thalamus ends in an ordinary vegetative bud. One half of a floral leaf is petaloid and the other half is foliaceous with serrate margin like that of an ordinary leaflet.

These two cases of monstrosity afford very strong arguments to prove the fact that a flower is a special kind of shoot.

79. Comparative studies in the embryogeny of the Convolvulaceæ : I. On a peculiar type of the embryo development in *Evolvulus nummularis*.

N. K. TIWARI, Benares.

The peculiarity consists in the fertilized egg producing at first a cell mass from which later a filamentous suspensor of about 6 cells is formed. From the end cell of this suspensor the embryo is then organized. Such a type of development does not seem to have been described for any other plant before. The endosperm is of the nuclear type and is poorly developed even when the embryo itself is far advanced.

80. Comparative studies on the embryology of the Myrtaceæ :
I. The embryo-sac development of *Callistemon linearis*.

N. K. TIWARI, Benares.

The archesporium is hypodermal, consisting sometimes of one cell, sometimes of several. Only one develops, however, further though the others might sometimes persist and multiply. In further development a parietal tissue is formed, resulting in the sporogenous cell becoming deep-seated. T-shaped tetrad of megaspores is developed. The chalazal megaspore functions. The young embryo-sac is 8-nucleate. Antipodals degenerate quite early and the polar nuclei fuse. The mature embryo-sac thus consists of the egg-apparatus and the secondary nucleus. The synergids in the early stages are beaked.

81. Studies on the life-history of *Eugenia jambolana* : I. A note on an abnormal type of embryo-sac of *Eugenia jambolana*.

N. K. TIWARI, Benares.

This paper describes an embryo-sac of an abnormal structure which the writer has found in the course of his studies on this plant. The abnormality is found in the mature embryo-sac and consists in the occurrence of three polar nuclei in place of the usual two. Only one embryo-sac of this abnormal structure has so far been observed.

82. Studies on the life-history of *Eugenia jambolana* : II.
On an abnormal type of development of the embryo-sac of *Eugenia jambolana*.

N. K. TIWARI, Benares.

In this paper is described an abnormal type of development of the embryo-sac. To begin with the megaspore, as usual, initiates the development. But at a very early stage its development becomes arrested. Simultaneously a neighbouring cell of the nucellus begins to enlarge and gradually takes on the characters of the megaspore ; from this cell the embryo-sac is developed. The normal megaspore degenerates.

83. On the structure of dicotyledonous angiospermic embryo.

S. C. BANERJI and K. G. BANERJEE, Calcutta.

An investigation of the source of additional shoots which grow out normally and incidentally from the cotyledonary axil of *Arachis hypogæa* L. and *Mangifera indica* L. respectively, led to the discovery of cotyledonary axillary buds as parts of the body of the embryo in its dormant state in *Ocser arietinum* L. and *Pisum arvense* L. Similar but inoperative

buds have been found on the body of the embryo as post-germination structures in *Lagenaria vulgaris* Ser., *Tamarindus indica* L. and *Ricinus communis* L. The plumular axis of the dormant embryo in the two latter instances with epigeous cotyledons is very rudimentary and is not differentiated. It does not bear recognizable buds at its cotyledonary axil. In *Ricinus* the bud can be inferred in its primordial stage only as a group of cells at the nodal region of the plumular axis. The presence of the cotyledonary axillary buds on the tigellum of the embryo and of the leaf-trace supplying the cotyledons lends a further support to the foliar conception of cotyledons.

84. Development of anomalous secondary vascular rings in the roots of *Spergula rubra* D., and *S. pentandra* L.

P. C. JOSHI, Lahore.

Secondary rings of growth outside the central stele have already been recorded in certain members of the family Caryophyllaceæ, but so far the exact mode of their origin has not been studied in any case. A similar anomaly has been found in the root of the above two plants, growing in Lahore.

A detailed investigation revealed that the primary root structure is quite normal and is diarch. The primary cambium develops and functions in the usual way. It is the pericycle layer which behaves differently from the normal. Its cells enlarge, undergo repeated divisions and so form several layers of parenchymatous cells outside the central cylinder. Later on strips of cambium are differentiated from some of these cells, which develop two to three rings of collateral vascular bundles one after another. These secondary zones of growth are separated from each other and the central cylinder by four to five layers of parenchyma. The cambium of two adjacent bundles of the same ring may become continuous with each other. No connection on the other hand ever occurs between the bundles of two different rings.

The probable physiological and phylogenetic significance of this type of growth is discussed in the paper.

85. Morphology of *Ammania baccifera* L.

A. C. JOSHI and J. VENKATESWARLU, Benares.

The paper describes the details of microsporogenesis, megasporogenesis, embryo-sac, endosperm, embryogeny and the structure of the mature seed.

Microsporogenesis is characterized by the development of tapetum from the sporogenous tissue. Otherwise it is normal. The mature pollen grains are 2-nucleate and possess three plugged germ-pores arranged in an equatorial manner.

The primary archesporium in the ovule is many-celled and differentiation of 2 or 3 megaspore mother cells is quite common. A functional megaspore mother cell gives rise to 3 or 4 megaspores. Out of these the chalazal one develops into the 8-nucleate embryo-sac in the normal manner. This embryo-sac differs from that of other known Lythraceæ in the rather 'not early degenerating' nature of the antipodals and in the structure of the synergids. In many instances more than three antipodal cells are seen, due to a secondary division of one of the original three. The synergids lack conspicuous vacuoles, fuse with each other laterally at an early stage and become multinucleate by repeated amitotic division of the original nuclei. They further persist up to a late stage of embryo development. The polar nuclei rarely fuse and there is evidence to suggest the development of endosperm without the occurrence of triple fusion.

A tapetal layer is developed around the megaspore mother cell. It persists around the functional megaspore and during early stages of embryo-sac. During further development of the embryo-sac, it is disorganized in the micropylar region but persists around the chalazal end of the embryo-sac. A conducting tissue consisting of elongated cells with dense contents is differentiated in the nucellus connecting the chalazal end of the embryo-sac with the vascular supply of the ovule which ends in the chalazal. This along with the tapetum helps in the nutrition of the embryo-sac.

Endosperm remains only nuclear and very scanty. The embryogeny differs from the *Capsella*-type in the basipetal differentiation of dermatogen and in the behaviour of the hypophysis. The latter, a lenticular cell, divides once. Its chalazal daughter cell differentiates into the perilemna of the root without undergoing any further divisions. The other basal daughter cell gives rise to two tiers of cells, the basal one giving rise to calyptragen and the apical one to the dermatogen of the root apex. The suspensor is a short slender uniseriate structure, and consists mostly of a row of three or sometimes of four cells. The differentiation of the three histogenic layers is very clearly seen during embryogeny of this plant. The mature embryo is loaded with starch, the form of which varies in the different layers of the embryo. A few cases of abnormal embryogeny have been seen. A small amount of nucellus (the outermost layer) persists in the mature seed in the form of perisperm. An air cavity appears in the seed by breaking down of the cells near the chalazal end towards the side of the funiculus and serves to make it buoyant. The inner layer of the inner integument develops a tracheidal structure in the mature seed.

86. Morphology of *Lawsonia alba* L.

A. C. JOSHI and J. VENKATESWARLU, Benares.

Development and structure of pollen agrees with that of *Ammania baccifera*. Spore output per anther, however, is larger than in the other species. Cytokinesis has been seen in this plant to take place by vacuole formation. Degenerations in the sporogenous tissue of the anther have been seen at various stages, at the spore-mother cell stage, in young pollen grains still enclosed within the mother cell wall and in mature grains. In some instances, the entire sporogenous tissue of a lobe has been found to degenerate.

The primary archesporium is many-celled in the ovules just as in *Ammania baccifera* and more than one functioning megaspore mother cells, tetrads of megaspores and embryo-sacs in an ovule have been frequently seen. The antipodals degenerate at an early stage and besides this the whole embryo-sac has been very frequently found to degenerate at its various stages of development. The synergids are hooked and develop caps of cellulose. The polar nuclei fuse with each other unlike those of *Ammania*.

87. A study of microsporogenesis in two Menispermaceæ.

A. C. JOSHI and B. V. RAMAN RAO, Benares.

The paper describes the results of a study of meiosis and pollen development in two local members of the family Menispermaceæ, namely *Cocculus villosus* D.C. and *Tinospora cordifolia* Miers.

The resting nucleus of both *Cocculus villosus* and *Tinospora cordifolia* shows a reticulum, upon which are distributed the prochromosomes and as the stage advances a continuous chromatin thread appears which becomes gradually prominent. This thread stands tight and stiff on the nucleolus, which is found to shift its position to one side of the nuclear cavity. Any parallelism of threads is not clearly made out during these stages.

As synizesis sets in, a clear space is gradually created on one side of the nuclear cavity, and the thread contracts with its loops. The nucleus is found to increase slowly in size.

At the time of maximum synizesis contraction the thread becomes, more or less, a compact mass and the nucleolus is usually not included in it. This synizesic mass in *Tinospora* stains much darker than in *Cocculus villosus*.

After synizesis, a thicker, homogeneous spireme comes out in *Cocculus villosus*, and there seems to be a definite connection between the thread system and the nucleolus. It appears that the greater part of the chromatin during synizesis is passed on from the thread system to the nucleolus, and during the development of the 'open spireme', it is returned to the thread system, the nucleolus acting as a temporary store-house.

The 'open spireme' passes into the 'second contraction' phase in *Cocculus*. The uniform spireme stage, and the second contraction stage are totally eliminated in *Tinospora*.

The post-synizesic stages in the nucleus of *Tinospora* and the stages after second contraction in *Cocculus* are quite similar. In both cases an uneven thread system with thick chromatin masses emerges out and fills up the entire nuclear cavity. These chromatin masses are connected end to end and they become the univalent chromosomes, which acquire their characteristic size and form by gradual condensation. The pairing of chromosomes, both in *Cocculus* and *Tinospora*, takes place telosynaptically.

The number of bivalents is 19 in *Cocculus villosus* and 12 in *Tinospora cordifolia*. In the latter plant one pair is longer than the rest. No evidence of heterochromosomes is found in both of these plants.

The intra-nuclear origin of the achromatic figure has been clearly seen in *Tinospora*, and it is bipolar at all stages. In *Cocculus* also, there is no trace of a multipolar spindle.

The association of the homologous chromosomes is very intimate at metaphase so as to conceal their identity. No longitudinal split in the univalent chromosomes is visible during anaphase or telophase. Lagging behind of some chromosomes is commonly seen during anaphase. During the interkinesis definite nuclei are organized with nuclear membranes and nucleoli, but the individual chromosomes remain distinct during this stage. Evanescent cell plates appear between the two daughter nuclei.

The homeotypic division presents nothing unusual. There is equal distribution of chromosomes to the grand-daughter nuclei.

Cytokinesis is accomplished by furrows. The pollen-tetrads show both tetrahedral and bilateral arrangement. The latter is more common in *Tinospora* than in *Cocculus*.

Some of the pollen grains are seen degenerating in *Cocculus*, while still inside the mother cell-wall, and this degeneration is seen in *Tinospora* in nearly mature pollen grains. The number of such pollen grains is small in both the cases. The pollen grains are shed at the 2-nucleate stage. They possess a well developed exine and intine and a few germ pores. The exine is finely sculptured in *Tinospora*, but quite smooth in *Cocculus*. The germ pores are plugged in *Tinospora*, but are quite simple in *Cocculus*.

The tapetum in the anthers both in *Cocculus* and *Tinospora* arises from the sporogenous cells. The uni-nucleate tapetal cells divide mitotically about the time of synizesis in the microsporocytes and remain binucleate till the end.

88. A contribution to the chromosome numbers of the Chenopodiaceæ.

A. C. JOSHI, Benares.

The paper describes the number of chromosomes in *Suaeda fruticosa* Forsk. These have been counted from the apical meristem of the shoot

and the diploid number has been found to be 36. A comparison is made with the chromosome numbers known in the other *Chenopodiaceæ* and also between those of this family and the family *Amarantaceæ*. It is seen that the numbers are some multiple of 3, 6, 9, 18 and 27, and the numbers in the two families show very close correspondence. This greatly supports the close relationship of the two families, which is already well founded on grounds of morphology.

89. Microsporogenesis in *Sesamum indicum* L.

L. B. KAJALE, Benares.

The archesporium in the anther lobes is seen as a subepidermal sheet, one cell thick, 6-8 cells broad and 25-30 cells long. By the first periclinal division of these cells, the primary parietal and the primary sporogenous layers are differentiated. The cells of the latter without undergoing any further divisions develop into the spore-mother cells. The primary parietal layer undergoes periclinal division and the inner layer formed thereby becomes directly the tapetum, while the outer one by further periclinal divisions gives rise to four layers of parietal tissue inside the epidermis of the anther. On the inner side, the tapetum is differentiated from cells lying close to the sporogenous tissue. At an early stage these cells undergo a periclinal division and the daughter cells adjacent to the sporogenous tissue develop into tapetal cells. The tapetal cells are binucleate throughout their life.

The process of meiosis is interesting on account of (a) the extrusion of karyotin bodies from the nucleus and (b) the appearance of a perinuclear zone around the dividing nuclei of the sporocytes.

Cytokinesis takes place by furlrowing and both isobilateral and tetrahedral methods of spore formation are found, though the latter is more common.

In a number of cases the rudiment of the 5th stamen has been seen. It is without vascular supply in all cases.

90. Variation of chromosome number in *Musaceæ*.

S. P. AGHARKAR and P. N. BHADURI, Calcutta.

The diploid chromosome numbers in the following species and varieties of *Musa* and *Heliconia* have been determined:—

Musa paradisiaca L. sub. spec. *sapientum*, varieties—*champakela*, *keanchakela*, *amritasagar*, *dudsagar*, *agniswar*, *sabri*, *kabri*, *aithya* (bichikela), and *penag*.

Musa cavendishii Lamb.—var. *kabulikela*.

Musa rubra Wall. from Assam.

Musa superba Rox.

Heliconia metallica Planch.

Variation in the number of chromosomes has been observed in the different species of *Musa* as well as in different varieties and sometimes even in different cells of the same tissue. Polyploidy in *Musa* has been discussed in the light of both White's and Cheesman's theories.

PHYSIOLOGY.

91. Studies on photochemical action in plant respiration.

SHRI RANJAN, Allahabad.

A simple apparatus for the measurement of respiration rate of land plants, below room temperature, is described.

The fall of the respiration rate at the 'floating' part is due to the relative inactivation of the reacting molecules in darkness, and is definitely not due to starvation.

The inactivation proceeds in discontinuous jerks, thus the fall at the floating part is also in sudden jerks.

The 'protoplasmic' respiration is the real respiration rate in darkness.

By the extrapolation of curves, it has been possible to show, that the respiration rate of leaves after a period in light is similar to the respiration rate at the floating part.

These extrapolations have also shown that the respiration rate of pigmented leaves is very much more *in light*.

The respiration rate of non-pigmented tissues, like the roots, is not affected by light.

The acceleration of the respiration rates in light at 40°C. is less than that at 35°C., while the acceleration at 27°C. is the highest.

The acceleration at 20.5°C., in light, is very feeble.

These results prove that the respiration rate of green tissues is governed by both temperature and light, of which temperature is of more vital importance.

Temperature alone cannot increase the reaction beyond a certain limit. At higher temperatures, e.g. 40°C. the reacting molecules are already in a more or less highly activated state, thus light cannot accelerate the reaction to a much greater extent. In such cases the increase, in light, is only twice. At lower temperatures, however, say at 27°C., the reacting substances being less activated, the rise in the respiration rate is as much as four times. While at still lower temperatures, e.g. 20°C. light fails to increase the respiration rate, which now gets limited by temperature. This is in agreement with many of the exoenergetic photochemical reactions *in vitro*, which do not follow *Einstein's law of photochemical equivalence*.

92. A preliminary study on the physiology of sugarcane.

USHA CHATTERJI, Allahabad.

A study on the physiology of a few varieties of sugarcane has been undertaken with a view to get an idea about the physiological history of these plants.

Osmotic pressure of the canes seems to decrease progressively from tip downwards. A study of the respiratory curves of various portions of the stem shows that respiratory intensity is greatest towards the tip, the intensity decreasing progressively downwards. Similar results are also obtained when osmotic pressures and respiratory intensities of older leaves are compared with those of the younger. Contrary to the respiratory intensity the sugar content seems to increase from tip downwards.

The dry weight of the lower portions of the cane is much greater than that of the tip but the ash content seems to be in the reverse order. The amount of volatile matter is rather small in the tip regions but considerably increases towards the lower regions. The water content shows a rise from the lower regions towards the upper.

93. Influence of nutrition on sexual expression in maize.

M. ABDUL BARI and M. ABDUS SALAM,
Hyderabad, Deccan.

Dr. H. Chaudhuri had found that better nourished plants produced male inflorescences while ill-nourished ones produced female. The authors had an objection to the method of controlling nourishment adopted by Dr. Chaudhuri. Experiments conducted on laboratory scale with ordinary soil cannot be supposed to give reliable results, because, however the soil may be mixed, it cannot form an homogeneous mixture.

The method adopted by the authors was to culture plants in sand, deprived of organic matter as much as possible, and supply them with culture solution, so that the nourishment may be better controlled.

The first experiments were conducted in summer, and others in the rainy season. In the paper the details of the experiments are given; the results arrived at tally with Dr. Chaudhuri's, i.e. better nourished plants produce inflorescences in which male element is dominant, and ill-nourished plants produce inflorescences in which female element is dominant.

94. Studies in the tropic curvature of certain angiospermous flowers—III.

T. C. N. SINGH, Sabour.

Several species of angiospermous flowers are under observation but at the moment experiments on *Papaver Rhoeas* L. alone deserve mention. The stimuli of gravity, contact or emasculation (both under bagged or un-bagged conditions) have apparently no effect on the curvature of the flower-pedicle which follows a normal course. But removal of sepals in very early stages affects the pedicle in such a way that it remains straight throughout the ontogeny of the flower without displaying any curvature whatsoever.

95. Formation of cuticle in relation to external conditions.

P. PARIJA and P. MALLIK, Calcutta.

Experiments on cuticle formation under different conditions of environment are described.

It is seen that (i) not dryness of the atmosphere alone but dryness coupled with light induces cuticle formation; (ii) the thickness of the cuticle varies with the degree of dryness and with the intensity of light; (iii) heat alone, apart from light, has no influence but heat coupled with light induces the formation of the cuticle to some extent; (v) red rays are ineffective while blue rays induce cuticle formation.

96. On the osmotic value relations of our plants—II.

J. C. SEN GUPTA, Calcutta.

This is a continuation of the author's work recorded last year and can be classified under three groups:—

About 30 more species of common plants (including herbs, shrubs, and trees) of the Bengal plains have been examined. The lowest values have been found in succulents (*Aloe* 3.014 Atm., *Bryophyllum* 5.784 Atm., *Euphorbia* 5.904 Atm.) and aquatic plants (*Nymphaea* 5.543 Atm.) and highest in *Grevillea robusta* 17.68 Atm., *Azadiracta indica* 17.92 Atm., *Poinciana regia* 17.20 Atm., and *Citrus sp.* 16.7 Atm.; the others had intermediate values.

Some mangrove plants from the Salt Lakes near Calcutta, and Port Canning were examined. They were characterized by considerably higher values than the preceding group. The highest value obtained was in *Tamarix Gallica*, 50 Atm. at Port Canning.

Examinations of some 50 species of plants (including more than 20 Gymnosperms and 5 Pteridophytes) from the Lloyd Botanical Garden, Darjeeling and its surroundings showed high values in *Cedrus Deodara* 19.72 Atm., *Spiraea sorbifolia* 17.56 Atm., *Callitris rhomboidea* 16.60 Atm., *Thuja orientalis* 16.12 Atm.; and low in a tree-fern 5.302 Atm., *Rhododendron grande* 6.025 Atm., *Geranium polyantha* 6.266 Atm.

Some variations (i) in the same plant:—(a) in the course of the day, (b) during the year, and (c) in leaves at different heights of insertion on the stem; and (ii) in the same species:—(a) in different habitats and (b) at different stages of growth, are recorded.

97. Course of transpiration in some mesophytes of Bengal.

P. N. MAZUMDAR, Dacca.

In the present paper an attempt has been made to investigate quantitatively the daily and annual variation in the course of transpiration of (i) *Vinca rosea* Linn.; (ii) *Hibiscus rosa sinensis* Linn.; (iii) *Ixora coccinea* Linn.; (iv) *Jasminum sambac* Ait., employing cut twigs for the experiments.

The variations of transpiration have been correlated with the variations in the meteorological factors and evaporation from atmometer. The times of maximum and minimum transpiration in the day and year and their variations in the same species have been noted including readings during the night hours.

The difference in behaviour in the different species has been compared with interesting results.

The regulations of the stomata have also been observed microscopically and correlated with the physical measurements.

Preparation for extensive investigation of a large number of Bengal species is in progress.

98. Effect of different temperatures on growth, etc., of different plants.

S. A. MALLIK, Lahore.

In this paper the effect of previous exposure to high and low temperatures on different soaked and dry seeds, on germination, growth, flowering, and fruiting, has been described.

99. Importance of herbaria to the study of Botany and allied subjects.

V. NARAYANASWAMI, Calcutta.

In the craze for spectacular shows, experimental magic and thrilling results, a quiet, unobtrusive and prosaic sort of a place like a herbarium, which is after all an epitome of the whole vegetable wealth of the particular region or regions, is certainly less enchanting and appealing to the generality of the present day botanists. It is despised by the non-systematists and less cared for by the authorities. But when the results achieved by such world famous herbaria like those at Kew, New York, Buitenzorg, and Berlin are known and realized, the neglect and the disregard which is shown to a herbarium by those other than systematists will vanish like the fog before the sun. The utility and the importance of every herbarium is decided by the object it is intended to serve. The author wishes to place before you briefly how a herbarium can be useful in not only promoting the study of botany in general, but also in advancing our knowledge in other directions as well, named agriculture, medicine, forestry, and industry.

100. Preliminary observations on the arrangement of mechanical tissues in some of the recommended varieties of rice of the Bengal Agricultural Department belonging to the two groups—Highland Aus and Transplanted Aman, as well as two wild rices of Eastern Bengal.

S. G. SHARNGAPANI and H. K. MAJUMDAR, Dacca.

Several varieties of both lodging and non-lodging habit have been studied. *O. sativa* Linn. var. *fatua* which grows in deep water situations only and *O. latifolia* Desv. a highland variety (Hill rice) were selected as extreme cases for comparison. Arrangement of the mechanical tissues in

all the strains studied is described. The study further shows that some structural peculiarities are probably hereditary and may, to some extent, be overcome by hybridization.

101. Studies in the physiology of crop plants: Part I. Water conditions and the growth of rice.

P. K. SEN and B. N. GHOSE, Calcutta.

Rice varieties were grown in pot culture and field plots under controlled conditions of water with a view to determine the optimum water requirements of the plant, critical stages of watering and the effect of partial submergence of the plant on its growth.

Marked responses to treatments of varieties have been obtained. In general there is an optimum of watering effect beyond which tillering is suppressed and flowering delayed.

102. Studies in the physiology of crop plants: Part II. The sugars of the leaf of rice, their translocation and bearing on the growth of the plant.

P. K. SEN and E. A. R. BANERJEE, Calcutta.

The total and reducing sugar content of the successive leaves of three varieties of rice are being determined at different periods of the day at various stages of the development of the plant. Morphological data have been collected so as to enable a study of the correlation between sugar content and growth of the plant.

The investigation has been designed also to elucidate the effect of the pigment on the photosynthesis of a purple variety of rice.

103. Green water-hyacinth and nitrogen fixation in soil.

P. K. SEN and S. ROY, Calcutta.

The influence of green water-hyacinth, fresh and previously rotted, with and without the addition of manure extract and lime, in the nitrification of soil has been investigated. The best result has been obtained with the green plant previously rotted with manure extract for a month and a half and applied to the soil with a dressing of lime.

A method of using the weed as a green manure eliminating the possible harmful effect due to high percentage of chloride ion present in the ash of the plant has been discussed.

104. Physiological studies in medicinal plants: Part I. Respiration rate and carbohydrate and nitrogen fractions in *Datura* leaves.

P. K. SEN and B. ROY, Calcutta.

The rate of respiration in *Datura* leaves in darkness falls steadily at first, the period of fall depending on the age of the leaf, after which it shows a tendency to recover and continues to maintain a level somewhat above the minimum for as long as 72 hours.

Starch, total and reducing sugars, and total nitrogen, protein, amino-acids and total alkaloid content of the leaves in the dark determined at intervals.

The inter-relation of carbohydrate and nitrogen metabolism and the respiratory activity discussed.

105. H-ion gradient in different stages of fruit ripening.

NONI PAL, Allahabad.

The pH and the titratable acidity of watery solutions of fruits of *Lycopersicum esculentum*, *Psidium guajava*, and three species of *Citrus* at different stages of ripening were found out. It was found that the actual acidity increased for some time and then decreased in the final stages of ripening. The titratable acidity also varied but did not always correspond with the actual acidity. Thus there was no direct relation between actual and total acidity.

106. The effect of injecting acids in leaves on the respiration and H-ion concentration.

NONI PAL, Allahabad.

Leaves of *Mangifera indica* were injected with N/10, N/20, and N/40 hydrochloric acid and oxalic acid and the respiration, total acidity and the pH were estimated. The respiration rose when injected with N/10, N/20 HCl, and N/10, N/20, and N/40 oxalic acid, but when injected with N/40 HCl it showed a slight fall. The highest rise was recorded in case of N/10 HCl. The titratable acidity increased in all cases, but the pH varied very little owing to high buffer action. It is therefore evident that the pH has nothing to do with the rise in respiration.

107. Study of crystals in *Momordica* (Cucurbitaceæ).

H. L. CHAKRAVORTY, Calcutta.

The genus *Momordica* exhibits the presence of copious deposits of Calcium salts in all parts of its body. They are deposited as cystoliths of calcium carbonate and as calcium oxalate crystals. Of these two different calcium salts the former is found mostly in the leaves and the latter is more or less confined to the stem and the petiole; they may also be found up to half of the midrib. The present study is based on two species of *Momordica*, viz. *M. charantia* Linn. and *M. cochinchinensis* Spreng. Crystals are generally present in the cortical parenchyma cells of the stem and the petiole; they are absent in the epidermal cells. In the root they do not occur. Most crystals are solitary rhombohedral crystals belonging to the monoclinic system. Twin or clustered crystals are also present. Combination of twin crystals (star-shaped), forming composite or complex forms have been observed in *Momordica charantia*. The star-shaped crystals of *Momordica charantia* differ from those of *M. cochinchinensis* in having more pointed and projected star-ends. The crystals are more numerous and distinct in the stem than in the petiole; star crystals are less numerous in the stem than in the petiole. Crystals are traceable up to certain distance of the midrib. They do not occur in the upper portion of the midrib, veinlets and in the general lamina. Crystals in the form of raphides and sphær-raphides are not present in the species examined.

Measurements: Star-shaped 18-24 μ ; Tetragonal 9-18 μ .

108. The course of vascular bundles in the stem and seedling of *Mirabilis jalapa* L.

B. R. MALHOTRA, Lahore.

A transverse section of the mature stem shows a peripheral ring of vascular bundles containing within it 12-15 medullary bundles, eight of which are arranged in the form of a ring in the centre.

By cutting serial sections it has been found that all 'medullary' bundles in *M. jalapa* are leaf-trace bundles. The eight innermost bundles enter the leaf as leaf-traces after a definite and regular course while the other 'medullary' bundles anastomose with them irregularly. Thus all 'medullary' bundles in *M. jalapa* are 'common' in nature. The bundles of the outer ring are all cauline.

Seedling.—Three vascular bundles pass from each cotyledon to the hypocotyl. The two lateral ones are larger than the median ones. Immediately below the insertion of the cotyledons there is a ring of small vascular bundles which fuse into two large bundles, situated at right angles to the place of the cotyledons. The lateral bundles from the cotyledons arrange themselves on the sides of these bundles, making a row of three on each side. The median bundles divide into two each and continue straight downwards. The two cauline bundles of the hypocotyl when traced downwards are found to move outwards and divide into three each and the remaining four (cotyledonary bundles) divide into many bundles and anastomose irregularly. Still further down a T.S. shows a ring of small vascular bundles consisting of the branched lateral bundles and the branched cauline bundles. The branches of the median bundles also become part of the same ring. The course of the bundles is similar to the course described by Hill in *M. longiflora* but differs from the description given by Gerard in *M. jalapa*.

109. A study of *Exormotheca tuberifera* Kash. and *Aitchisoniella himalayensis* Kash.

S. R. KASHYAP and SULTAN AHMAD, Lahore.

Exormotheca tuberifera.—The structure of the thallus and the sex organs has been confirmed. Cell division takes place in the venter even before fertilization and the calyptra becomes four-layered. The capsule arises from the epibasal part and the foot and the seta from the hypobasal part. The epibasal part divides into a mass of cells by periclinal and anticlinal walls and the wall of the capsule is differentiated from this mass rather late. Elaters are occasionally branched. The cap of the capsule is one-layered with elater like cells attached to it. Dehiscence takes place by splitting of the cap and four irregular cells.

Aitchisoniella himalayensis.—The structure of the thallus and the sex organs has been confirmed. The apical cell cuts off four series of segments. Air chambers arise in a schizogenous manner. The development of the antheridium is of the usual marchantiaceous type. Vertical walls are formed after the formation of a filament of four cells. The female receptacle has one to two involucre generally but may have three or even four sometimes. The archegonium has the usual structure. The primary neck-canal cell divides into two before the division of the primary ventral cell and there are four neck-canal cells. First division of the fertilized egg is transverse or oblique followed by a transverse wall in each of these cells. Thus a filamentous embryo of four cells is formed after which vertical walls appear. The capsule is formed from the epibasal and the foot and the seta from the hypobasal part. Spore mother cells do not become lobed. Elaters are occasionally branched. The apical cap of the capsule is two-layered with elaters like cells attached to it.

110. A study of *Athalamia pinguis* Falconer and *Athalamia pusilla* (St.) Kashyap.

S. R. KASHYAP and M. ASHRAF KHAN, Lahore.

Athalamia pinguis.—The structure of the thallus and the sex organs has been confirmed. Two antheridia may sometimes occur in one cavity. The antheridia and archegonia develop as usual in the Marchantiaceae. Spore mother cells become lobed before division. Elaters may be branched.

Athalamia pusilla.—The structure of the thallus and the sex organs has been confirmed. The growth takes place by means of an apical cell cutting off four series of segments. The development of the antheridium and the archegonium is of the usual type and an octant stage occurs in the development of the embryo. Spore mother cells present an amoeboid appearance before division.

111. The course of vascular bundles in the stem of *Bærrhaavia repens* Linn.

B. R. MALHOTRA, Lahore.

B. repens, like *Mirabilis jalapa*, shows characteristic arrangement of vascular bundles. The transverse section of the stem shows an outer ring of 15–20 small bundles. Within this ring there are a few medullary bundles. These medullary bundles vary in number. Usually there is an inner ring of 7–10 bundles outside which there are a few scattered bundles. Two of the inner ring of vascular bundles are always bigger than the rest of the bundles constituting the ring and are more deeply placed. On each side of these two bundles there are usually 3–4 bundles each.

It has been found by cutting serial sections that due to the varying number of bundles in the inner ring the individual bundles show slight irregularities in their individual course.

The three small bundles on each side of the inner ring pass on to a leaf at the node above. Each of the larger bundles divides usually into five branches. The three middle ones are destined to be the leaf traces of the node higher up, while the two lateral branches of each fuse with the adjacent lateral branches of the other bundle and form the two big bundles of the internode.

112. A tricotyledonary seedling in *Bærrhaavia repens* Linn.

B. R. MALHOTRA, Lahore.

While working on the seedling anatomy of *B. repens* the writer came across a seedling which showed apparently three cotyledons. Further examination disclosed the fact that one of these cotyledon-like leaves belonged to the internode higher up. The leaves in this species are opposite and decussate but the node above the cotyledons had only one leaf and the third apparent cotyledon occupied the position of the second leaf but had obviously travelled down. The internal anatomy also confirms this conclusion. The cotyledons have only two leaf traces each. The ordinary leaves have three. This peculiar third cotyledon had two traces in the upper part but one of the traces showed signs of division at the base.

113. The mechanism of the bursting of the fruits of *Impatiens balsamina* Linn.

P. PARIJA and P. MALLIK, Cuttack.

The mechanism of the bursting of Balsam fruits was investigated. Sections of the carpels at various stages were cut and stained with safranin for 24 hours and examined. Osmotic strengths of the cell sap at various stages of maturity were studied.

It was found that turgidity is not the only cause of bursting. It is helped by suberization of the cell-wall at the suture of the carpels.

114. The roots of *Psaronius*, intra-cortical or extra-cortical? a discussion.

B. SAHNI, Lucknow.

In the root-region of *Psaronius* generally two zones can be distinguished: an inner zone of relatively small roots which are very crowded and sometimes flattened in consequence, with a 'packing' of thin-walled filamentous cells; and an outer zone of larger, obviously extra-cortical, free roots, which are not distorted by mutual pressure. The inner roots were formerly regarded as intra-cortical, but since 1902, after Farmer and Hill (see discussion in Scott *Fossil Botany*, 1920, I: 271-275) the view has gained ground that they are also extra-cortical, the filamentous tissue being regarded as the compacted hairs derived from the roots themselves. This view was confirmed by Solms (1911).

After an examination of some material from Chemnitz the writer has been led to believe that the intra-cortical view was after all the correct one, and that Stenzel's interpretation best meets the observed facts. Along the outer border of the inner zone the writer finds many places where there is an unmistakable compact periderm-like tissue, in places a dozen cells deep, with the cells serially arranged. This 'periderm' is not in a continuous band all round, but this seems to be due to the fact that here and there the inner roots are bursting out through it so as to become free.

The absence of leaf-traces among the roots cannot be questioned but is explicable on Stenzel's view that 'the embedding tissue is a secondary zone, developed *pari passu* with the growth of the roots after the leaves had fallen' (Scott, p. 271).

115. *Rajmahalia paradoxa* gen. et sp. nov. and other Jurassic plants from the Rajmahal hills.

B. SAHNI and A. R. RAO, Lucknow.

Rajmahalia paradoxa is a unique type of fossil reminding one of the inflorescence of a *Dorstenia* both in size and shape, except that the rim is quadrangular with the angles well rounded. The central part of the concave surface shows a quadrangular area covered by numerous round scars, with a number of polygonal scars in between them. These round and polygonal areas seem to represent the ovules and interseminal scales of a Bennettitalean flower. The comparison with *Dorstenia* is only suggested as an aid to description: the affinities are quite obscure.

The other plant remains in the collection include *Equisetites*? cf. *E. rajmahalensis*, *Sphenopteris rajmahalensis* sp. nov. *Sphenopteris* sp., *Marattiopsis macrocarpa* (fertile and sterile leaves), *Gleichenites gleichenoides*, *Cladophlebis indica*, *Ptilophyllum* cf. *P. cutchense*, *Ptilophyllum* cf. *P. acutifolium*, *Ptilophyllum acutifolium*, *Nilssonia princeps*, *Dadoxylon* (*Araucarioxylon*)? *rajmahalense* Sahni.

The localities are Khairbani, Balbhadri, Bartala, Bunchapa, all in the northern part of the Rajmahal hills.

116. On the occurrence of *Choanephora cucurbitarum* on the fallen leaves and shoots of *Cassia tora*.

H. P. CHOWDHURY and R. S. MATHUR, Lucknow.

The occurrence of this facultative parasite has been reported on fading flowers of *Hibiscus*, *Cucumis*, *Gossypium*, and *Capsicum*. It was found by Prof. Sahni growing on fallen twigs and leaves of *Cassia tora* in Lucknow at the end of September. A cursory examination of the plants growing near the fallen infected twigs did not reveal its presence either on the floral parts or on the leaves. A single attempt to inoculate

the leaves and floral parts with live spores also failed to bring about the infection. Whether it is an active parasite as it is in other cases or it is to be found only on impoverished parts or only on detached twigs cannot be said with any certainty.

117. Note on a species of *Emericella* found in Lucknow.

H. P. CHOWDHURY and R. S. MATHUR, Lucknow.

This interesting member of the Plectascineæ has been found in Lucknow in abundance during the rainy season on living sporophylls of *Cycas* and also on fallen leaves and shoots of many other angiospermic plants. It consists of minute whitish ellipsoidal or barrel-shaped bodies on the cuticle of fallen leaves or on decaying shoots. They are the perithecia. Sometimes young perithecia were seen covered with the conidial stage. It may be *E. varicolor* found by Berkley in Secunderabad. Berkley did not find the conidial stage. Its presence as far as known to the writers has not been recorded in Northern India. Cultural studies are being made of this fungus.

118. Silicified plants from the Rajmahal series.

A. R. RAO, Lucknow.

Dr. Sahni placed at the writer's disposal for study a few silicified blocks from Nipania received from the Director of the Geological Survey of India. Very few Rajmahal species have been found in a petrified state; the present material is valuable as it has revealed several very interesting fossils: (i) *Tæniopteris spatulata* McCl. Sahni (*Proc. Ind. Sci. Congress*, 1932, p. 322) found mesarch bundles in the midrib suggesting a possible Cycadophyte affinity. Epidermal walls sinuous as in *T. vittata* (Bennettitales); stomata scattered between veins on lower side only and generally conforming to the Bennettitalean type. These facts confirm a Bennettitalean affinity. (ii) Long needle-like leaves with central vascular strand and palisade tissue all round; often attached to stems with pycnoxylic wood. (iii) Small appressed leaves of the Cupressineous type attached on a slender axis. (iv) Stems, large and small showing secondary wood with growth rings. (v) Megastrobili: (a) broad, cylindrical with ovules spirally arranged and partly buried in scales; integument three layered, micropyle facing cone axis; two-winged pollen grains on nucellus. (b) Lax, cylindrical, with ovules spirally and distantly arranged on slender axis; micropylar tube curved towards cone axis. (c) *Conites Hobsoni* Sahni (*loc. cit.*). (vi) *Microstrobilus*, transverse section showing 6 or 7 sporangia round a central axis, some containing 2-winged pollen grains (? cf. Abietineæ or Podocarpaceæ). (vii) Seeds, scattered in matrix, probably detached from some of the cones mentioned above. (viii) Two-winged pollen (scattered in matrix) two different sizes (possibly different species), some seen on the nucellus of megastrobilus (a). Winged pollen has not been reported so far from the Jurassic of India. (ix) Three-winged pollen (scattered). (x) Spores, different sizes, smooth-walled or verrucose.

Sections have been successfully stained some with safranin, others with gentian violet, with vivid results.

119. On a new species of *Botrydium* from Lucknow.

A. R. RAO, Lucknow.

B. intermedium sp. nov. M. O. P. Iyengar resembles the common *B. granulatum* in producing serial and intercalary rhizoidal cysts not bigger than the rhizoid itself. It resembles *B. tuberosum*, Iyengar (*Journ. Ind. Bot. Soc.*, IV : 1930, 1925) in producing swollen cysts at the ends of the rhizoidal branches and in the rhizoidal ends being swollen even

before the migration of the protoplasm into them. The author expresses his indebtedness to Prof. M. O. P. Iyengar for his help and guidance, and for naming the species.

120. *Rhizomopsis gemmifera* of Gothan and Sze.

H. S. RAO, Lucknow.

There is a suggestive resemblance between the photograph of a fossil from Kiangsu Province, China, described under this name by Gothan and Sze (*Nat. Res. Inst. of Geol. Acad. Sinica Mem.* 13, 1932 ?) and that of *Dictyopteridium sporiferum* Feistmantel, from the South Rewah Gondwana basin figured by Zeiller (*Pal. Ind.*, N.S., II: 24-26, 1902). The former is considered to be a rhizome with a number of small pits on it and here and there 'buds' bearing elongated processes. The latter also has pits on it; and the general shape of both is similar. Gothan and Sze conjecture that *Rhizomopsis* was perhaps the rhizome of *Gigantopteris*. An identity or affinity between the two would be of interest as the *Gigantopteris* flora of China is very distinct from the Lower Gondwana flora of India.

121. On a Sphærosiderite, containing a new species of *Dadoxylon*, from the Lower Gondwana Coal-measures of India.

H. S. RAO, Lucknow.

Describes a block of sphærosiderite from the Parbelia Colliery, Bengal (Horizon : Upper Damudas=Permian) containing a new species of *Dadoxylon* (*D. parbeliense*).

This is, in the author's opinion, the nearest approach to a 'coal-ball' so far discovered in the Indian strata. It is a heavy, black block, with a sort of spheroidal weathering on the surface, which shows a number of conchoidal hollows and rounded knobs. The latter are in fact spherical brown masses of well-preserved wood embedded in a coaly matrix. The whole specimen must have been a single block of wood which later on became cracked up into more or less cubical blocks. These blocks finally assumed a spherical shape and the cracks became filled up with coaly matter. The specimen externally resembles a 'coal-ball' from the 'rheinischen Braunkohle' described by Gothan and Hörich (*Jahrb. kgl. preuss. Geol. Landesanst.* XXXI, 1910). In structure it resembles another sphærosiderite described by Hsieh (*Bull. Geol. Soc. China* XII: 20-24, 1932) from the Liaoning Province of China. The term 'oolite' used by Hsieh for the spherical bodies is to be deprecated as there is no suggestion of concentric layers of growth formed by rolling. The mode of formation is totally different from that of ordinary oolites and pisolites.

The specimen is important as no 'coal-balls' similar to those of the European and American coal measures have yet been found in India. A search for further specimens of the same kind is full of important possibilities as it may lead to the discovery of petrifications of other Indian Lower Gondwana plants of which the anatomy is at present unknown.

122. On a new species of *Dipterocarpoxyton*, *D. Holdenii* from the Irrawadi system of Burma, with critical remarks on *D. burmense* Hold.

K. M. GUPTA, Lucknow.

Among Miss Holden's material from Burma preserved at the Sedgwick Museum, Cambridge, the author found a specimen of wood which is here described as *Dipterocarpoxyton Holdenii* sp. nov. Among other *Dipterocarpoxyton* so far described its closest resemblances are with *D. djambiense*

Berger from the older or pre-miocene of Sumatra (*Bull. Jard. Bot. Buitenzorg* 3, VIII : 495-498, 1927); among the living Dipterocarpaceæ *Shorea robusta* comes nearest. This material has also been compared with the original material of *D. burmense* Hold. (*Rec. G.S.I.*, XLVII : 267-272, 1916).

A careful re-examination of Holden's type specimen of *D. burmense* in further thin sections has proved beyond doubt that it is not a *Dipterocarpaceæ* at all, but may more profitably be compared with other families, e.g. the Ebenaceæ. The material of *D. burmense* is here redescribed and its resemblances with the wood of *Diospyros* are noted, but nothing definite can be said as regards the exact affinities of this wood.

123. On some silicified plant-remains from the Rajmahal Series of India.

B. P. SRIVASTAVA, Lucknow.

Numerous fossil impressions have been recorded from this classical area but so far only a few petrified forms have been described, notably by Seward, Bancroft, and Sahni. The locality Nipania, first discovered by Mr. G. V. Hobson of the Indian Geological Survey, has yielded a rich silicified flora, in which several new genera and species have been recognized. The majority of the thin sections have been stained with safranin and gentian violet with very good results. (i) A stem with *Lycopodium volubile* type of stele, possibly a petrified specimen of *Lycopodites gracilis* (O. and M.). (ii) *Fern rachises* (a) with a single C-shaped petiolar bundle, but of a complicated outline, (b) with a single petiolar bundle (? cf. *Gleichenia*) in a rachis with attached pinnæ or pinnules. (iii) *Pentoxylon Sahni* gen. et. sp. nov. Stems with usually five steles arranged in a ring; in each stele the centripetal development of the secondary wood far exceeds the centrifugal. (iv) *Nipanioxylon Gupta* gen. et sp. nov. Stems with usually eight steles arranged round a wide pith, which show equal development of the secondary wood on all sides. Possible leaf traces with numerous bundles are also seen in the cortex. (v) *Carnoconites* gen. nov. Fructifications with numerous fleshy seeds; stony and outer fleshy layer well developed; nucellus free from integument. (vi) *Conites* sp. Ovuliferous scales perhaps spirally arranged; one ovule on each scale rather distally attached; nucellus free.

124. A classification of palms based upon the ground tissue of the stem.

K. N. KAUL, Lucknow.

On the suggestion of Dr. B. Sahni who has been engaged on a comprehensive work on Indian petrified palms, the author studied the anatomy of a large number of modern palms with a view to classify them on their anatomical structure alone, and to ascertain if possible the natural affinities of the numerous fossil species which are at present inevitably grouped under the form genus *Palmoxylon*. As Dr. Sahni suggested, an investigation on these lines if successful would be of great value from the point of view of the palæobotanist. The purpose of this note is to record a few facts which seem to indicate that the hope above expressed is justified.

The following genera were studied:—*Phoenix* (10 spp.), *Chamaerops* (1 sp.), *Rhapis* (2 spp.), *Corypha* (2 spp.), *Licuala* (4 spp.), *Livistona* (3 spp.), *Sabal* (2 spp.), *Hyphæne* (2 spp.), *Latania* (1 sp.), *Borassus* (1 sp.), *Raphia* (1 sp.), *Metroxylon* (2 spp.), *Zalacca* (1 sp.), *Caryota* (3 spp.), *Arenga* (4 spp.), *Wallichia* (2 spp.), *Bentinckia* (1 sp.), *Chrysalidocarpus* (2 spp.), *Oreodoxa* (2 spp.), *Howea* (1 sp.), *Oncosperma* (2 spp.), *Cyrtostachys* (1 sp.), *Ptychosperma* (2 spp.), *Loxococcus* (1 sp.), *Dictyosperma* (1 sp.), *Pinanga* (2 spp.), *Areca* (3 spp.), *Bactris* (2 spp.), *Attalea* (1 sp.), *Elæis* (1 sp.), *Cocos* (1 sp.), and *Phytelephas* (1 sp.).

In the admittedly artificial classification of Stenzel, Mohl and others such characters as form of sclerenchyma, number of vessels, size, form, and distribution of bundles were considered to be of diagnostic value. The author has found, however, that nearly all these characters are very unreliable. He thinks that the ground tissue is of primary importance, and that it is possible to classify the different genera on this character alone. The different species of a particular genus show only one kind of ground tissue with only minute variations, although in some cases the species concerned grow in different environments and have different habits, as in *Arenga*, *Phoenix*, etc. If, as here suggested, the ground tissue is a character of diagnostic value for generic distinctions, the form genus *Palmoxylon* can be split up into a large number of natural genera of which the affinities or even identity with modern genera could be ascertained with some degree of confidence.

125. Studies in respiration of leaf in various stages in its life-history.

A. B. SARAN, Sabour.

It is well known that the initial rate of respiration of young leaves varies considerably in different species and that on wounding the respiratory activity of a plant organ is enhanced. In *Anacardium occidentale* Linn. studied by the author it has been demonstrated that the highest respiratory activity is displayed by younger leaves followed by a decline with advancing age. On wounding curiously enough, no further rise in respiration is noticeable in such leaves. A rise in respiration, however, is evident only when the rate falls down to 13.3 mgs. per two hours (10 grs. fresh wt. of leaves). A discussion of results is given in conclusion.

126. A note on the respiratory quotient of leaf (green and coloured) in *Euphorbia pulcherima*.

A. B. SARAN, Sabour.

The intake of oxygen and the outgo of carbon dioxide was studied both in green leaves as well as in coloured bracts of *E. pulcherima*. As a result it has been found that the respiratory quotient (CO_2/O_2) of green leaves is 1, whereas of coloured bracts it varies from 2.0 to 2.2. Finally, a possible explanation of this marked divergence in the respiratory quotients is appended at the end of the paper.

Section of Zoology.

President :—DIWAN ANAND KUMAR, M.A.

Presidential Address.

SPICULES AND CLASSIFICATION OF TETRAXONIDA.

It is an honour to have been asked to preside over this Section and I tender my best thanks to those who out of generosity have nominated me as President. It is no exaggeration, to call their action generous, for they must have been as fully conscious of my limitations for occupying this chair, as I am myself. In view of these limitations, I have chosen a subject, with which I can claim a certain amount of familiarity, though even here I can only speak, as a person, who has gathered information from different sources, rather than as one with any authority. The sponge spicules have for long been the subject of minute and detailed study, from many aspects, and a review, even a short one, of such vast material would be an impossible task within a limited time. I am therefore confining myself to giving here a brief outline of present day ideas regarding the phylogeny of the important forms of Tetraxonid sponge spicules and also the changes which our knowledge has wrought in the classification of this order; for the chief aim of a natural system of classification is to express in brief the most probable affinities of the various types comprising a group of animals.

The Tetraxonid sponge spicules have been divided, with respect to size, more for the sake of convenience, than on any radical morphological grounds, into two chief categories. The megascleres or large spicules which mainly serve the purpose of giving firmness and support to the body of the sponge and found in a definite orientation; and microscleres or minute spicules which generally lie haphazardly, scattered throughout the sponge body, without any ostensible purpose.

Professor Sollas writing as late as 1888¹ says of the microscleres that 'it is from them that the megascleres have been derived' and again discussing the phylogeny of the scleres it is stated that 'the interest attaching to the microscleres is in inverse ratio to their size,² for they represent the primitive material from which the megascleres have been derived by increased growth'. While dealing with the origin of the triænes,

¹ Sollas, Challenger Report, Vol. XXV, 1888, p. LXI.

² Sollas, Challenger Report, 1888, p. LXVI.

Sollas¹ was more inclined to the view that it was derived 'from a rhabdus by terminal cladosis of one of the ends'. Minchin² in his admirable article on Porifera in Lankester's Zoology though not so positive as Sollas still holds the view that 'the tetraxon type itself could be considered as a modification of the polyaxon' (which is confined to microscleres) and has probably been derived from it. What material alterations have taken place in our ideas has been the result of works of Maas, Butschli, Lundbeck, Lendenfeld, Vosmaer, Topsent, Dendy, and Hentschel, to mention the more important names out of a host of workers.

In 1905, Dendy proposed the name Homosclerophora for a sub-order of Tetractinellida to replace the old name Microsclerophora of Sollas, and included in it the single family Plakinidæ to the exclusion of all others. He pointed out that 'the Homosclerophora are thus left as the natural starting point of the Tetraxonid series, a position clearly indicated for them by Lendenfeld in his work on the "Tetractinellida of the Adriatic"' and further in the same connection that 'owing to their primitive character, the Homosclerophora form a very important and interesting sub-order and it is here that we must seek for the origin not only of the various types of Canal System, but also of the almost innumerable types of both micro- and megascleres met with among the Tetraxonida'.

We shall now deal in some detail with the spicules of the Homosclerophora consisting of the single family Plakinidæ with genera *Plakina*, *Plakortis*, and *Dercitopsis*. In these forms there is no differentiation between microscleres and megascleres, and the spicules occur haphazardly throughout the sponge body. *Dercitopsis minor* (Dendy)³ possesses spicules which show great variations in the number of rays present. They may be 2, 3, 4, or even 5-rayed.

The four-rayed forms seen in *Dercitopsis minor* (Dendy) are good examples of a primitive tetract or calthrop, all angles and all rays being equal. The five-rayed forms or pentacts are rare, three-rayed forms are common, and two-rayed forms or diacts very common and approach the oxea. Numerous transitional forms in which suppression of rays can be seen are also found. In the perfect diacts the angle between the two actines is almost gone and the spicule is straight, but such spicules often show traces of their origin in the presence of slight bodily swelling. The size of the spicules also varies considerably though they are never large enough to be megascleres nor small enough to be microscleres.

According to Dendy we see here the commencement through meristic and substantive variations of the great lines

¹ Sollas, Challenger Report, 1888, p. LXIX.

² Minchin, Lankester's Text Book of Zoology, 1900, p. 132.

³ Dendy, *Trans. Linn. Soc.*, Vol. XVII, 1916, p. 229.

of divergent evolution which have led to the higher groups of Tetraxonida. The distinction into megascleres and microscleres which becomes so pronounced in the higher forms is as yet indicated by mere variation in size of the spicule but we see clearly the origin of the diact and polyact types, the one by the suppression, the other by multiplication of rays.'

The species of Plakinidæ show various combinations of above types, e.g. *D. mamillaris* has only tetracts and diacts and *Plakortis* only triods and diacts. The differences that are faintly visible in the Plakinidæ become well pronounced in the higher groups of Tetraxonida and we see clearly two types of spicules becoming well established, i.e. the megascleres and microscleres. We shall deal with the phylogeny of these two types separately.

In the family Pachastrellidæ, calthrop is the main characteristic spicule in which all the four rays are almost equal in size and meet each other at equal angles. These are very similar to the tetractinate spicule of Plakinidæ but are so large in size that they must now be regarded as definite megascleres. The next step in the evolution of the megascleres consists in a differentiation between three out of the four rays forming a head or cladome, the fourth ray becoming the rhabdome by becoming longer than the other three. The individual rays of the cladome are called the cladi, which are generally equal in size and meet the rhabdome at equal angles. Spicules of this kind are called triænes and exhibit an orientation within the body, generally with the cladome pointing outwards and the rhabdome pointing inwards towards the centre of the sponge. The cladome is thus able to give definite support in various ways to the surface of the sponge.

These triænes met with in a number of families present various modifications.

If in a calthrop one of the rays becomes greatly elongated whereas the other three remain equal in size, retaining more or less accurately the angles of the tetract calthrop we obtain a plagiotriæne as in *Stelletta brevis* (Hentschel).¹ If the rays of a plagiotriæne are bent slightly backwards so as to approach a right angle with the rhabdome we get an orthotriæne as in *Stelletta tuberosa* (Hentschel).² A further bending backwards of the cladi results in an anatriæne as in *Tetilla grandis* (Sollas).³ Hentschel in his figures for *Stelletta tuberosa* has shown anatriænes in which the cladi are only slightly bent backwards and these may well be regarded as intermediate between the typical anatriænes as seen in *Tetilla grandis* (Sollas) or *Cinachyra isis*⁴ and the orthotriænes of *S. tuberosa* (Hentschel).²

¹ Hentschel, *Fauna. S.W. Aust.*, 1909, p. 357.

² Hentschel, *Fauna S.W. Aust.*, 1909, p. 354.

³ Sollas, Challenger Report, Vol. XXV, 1888, Pt. V.

⁴ Dendy, *Trans. Linn. Soc.*, Vol. XVIII, 1921, p. 16.

If on the other hand the cladi instead of bending backwards bend forwards and the angles between each cladus and the shaft increases, the resulting spicule is a protiaene as in *Cinachyra phacoides* (Hentschel).¹ So much then for the forms resulting by the variation of the angle between the shaft and the cladome.

A number of different forms are produced by branching of the cladi. These are generally met with in the ortho- and plagiotriaenes, where the cladi divide into two and the resulting form is a dichotriaene as in *Anthastra communis* (Sollas).² The most remarkable forms produced by such branching of the cladome are the phyllotriaenes, as in *Discodermia discifurca* (Sollas).³ In these forms the shaft is greatly reduced, the cladi are flattened and considerably branched in one plane. Discotriaene is another form in which the shaft is reduced and the cladi are flattened and expand so as to meet at their margins. The resulting spicule has the appearance of a drawing pin with a circular disc from which projects the shaft as a small spike. This is well seen in *Discodermia interspersa* (Kumar),⁴ which demonstrate quite clearly the development of a discotriaene from a primitive tetract. Further variation in the form of the triaene results by one or two or the cladi becoming shorter or incompletely reduced.

In *Tetilla leptoderma* (Sollas)⁵ we find protriaenes in which one of the cladi is reduced in size and a further reduction leads to the disappearance of one of the cladi resulting in a spicule which is a prodiaene, as in *Cinachyra barbata* (Sollas).⁶ A similar reduction in one of the cladi of an orthotriaene produces an orthodiaene as in *Tribrachium schmidtii* (Sollas).⁷ Forms like *Tetilla leptoderma* and *T. sandalina* (Sollas),⁸ show a number of triaenes in which two of the three cladi are reduced and only one remains behind giving rise to the promonoaene spicule as seen also in *Thenea wyvillii* (Sollas),⁹ and various other sponges.

Craniella nimia (Topsent)¹⁰ is an example of this gradual reduction of cladi.

In the anatriaene the reduction of a single cladus resulting in an anadiaene is exceptional but reduction of two cladi is much commoner so much so that in *Tetilla pilula* (Dendy)¹¹ anamonoaenes are the predominant type.

¹ Hentschel, *Fauna S.W. Aust.*, p. 286.

² Sollas, Challenger Report, Vol. XXV, 1888, Pt. XIII.

³ " " " " XXV, 1888, Pt. XXXII.

⁴ Kumar, *Record, Ind. Mus.*

⁵ Sollas, Challenger Report, Vol. XXV, 1888, Pt. 1.

⁶ " " " " XXV, 1888, Pt. XXXIX.

⁷ " " " " XXV, 1888, Pt. XVII.

⁸ " " " " XXV, 1888, Pt. XLI.

⁹ " " " " XXV, 1888, Pt. VI.

¹⁰ Topsent, *Campg. Sci. De. Monaco*, Vol. LXXIV, 1928, Pt. V.

¹¹ Dendy, *Rep. non-Calcareous sponges, Okhamandal*, 1916, p. 104.

A peculiar type of triæne which does not fit into this series is the mesotriæne. This is not a tetract spicule at all. It seems to have been produced by the addition of a new ray in continuation with the rhabdome. Similarly amphitriæne is another curious form in which there are two whorls of cladomes at each end of the rhabdome. This however occurs so rarely that according to Dendy it may be looked upon as an abnormality.

Coming now to the diactinal forms, i.e. spicules with two rays only, we find that the chief and typical representative of this is the oxeote which is straight, fusiform, and pointed at each end. According to Dendy this type arises from the plakinid spicule by two out of the four rays of a primitive tetract becoming reduced. If in such a reduced spicule the angle between the two rays is lost and they come to lie in a straight line, the resulting spicule is an oxeote. In a number of instances this primitive angulation between the two rays is still retained as in *Acanthella ramosa* (Kumar)¹ and *Histoderma encrusta* (Kumar).² Mention must here be made of the fact that the oxeote spicule may in some cases be derived by the straightening of the promonoæne and though in its essence this process is the same as the one mentioned above such oxeotes have to be regarded as secondary in nature.

In the diactinal type a great variety of forms is met with. If the spicule is cylindrical and points abruptly, it is termed a tornote, if bluntly rounded at each end, it is called a strongyle and those with knobbed ends, a tylote. The centre of a diactinal spicule naturally lies in the middle and in certain cases these may be indicated by a swelling near the middle in which case the spicule is called a centrotylote.

Among the megascleres the next type that we have to consider is the monactinal and it appears to have arisen late in the course of evolution. One can derive this type from the diactinal by the suppression of one ray. The simplest of the monact is the style or stylote, in which one end is sharply pointed whereas the other is blunt or rounded off.

Although it may be said to be generally correct that a style or monact is derived by the diact losing one of its rays, one cannot help feeling that it is possible for it to have arisen by the reduction of the entire cladome of a triæne. A number of instances of such spicules are found where the axial canal of a triæne is still visible in a tylostyle or in a style as in *Thenea delicata* (Sollas).³ *Hymeniacidon caruncula* (Topsent)⁴ and the bases of the tylostyles of *Pseudosuberites mollis* (Topsent, *ibid.*) show swellings which obviously point to their being

¹ Kumar, *Records of the Indian Museum*.

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³ Sollas, "Challenger Report", Vol. XXV, 1888, Pt. VI.

⁴ Topsent, *Bull. de Inst. Oceanographique*, 1925, p. 16.

reduced cladome heads. Again, according to Dendy, the style may be the result of a simple rounding off of one end of the oxeote as is apparently the case in the genus *Donatia*. In such cases it becomes very difficult if not impossible to distinguish a monact from a diact and in order to determine this point one has to rely on other features and the position of the sponge in relation to others.

We now come to a consideration of the microscleres. These spicules exhibit two fundamental types, each of which has evolved into a series of forms. These types are the polyact or astrose and diact or sigmatose. Both of these types are fore-showed in the spiculation of Plakinidæ. As has already been mentioned there is no differentiation between mega- and microscleres in this family. By an increase in size and orientation in the body we get the megascleres; whereas a further reduction in size of the same types of spicules results in the microscleres. The Plakinidæ, e.g. *Dercitopsis minor* shows tetract and pentact spicules; by an increase in the number of rays of a primitive tetract we get to the beginning of the astrose type of microscleres. By a reduction in size and also in the number of rays of a tetract we get a diactinal microsclere. If the diact retains an angle which generally is reduced to a curve we get the simplest type of sigmatose microsclere which is called the sigma.

According to Dendy the origin of the simplest aster consisting of six to seven rays is seen in the pentact spicule of *Dercitopsis*. A form like this with sharp rays and no centrum could be described as an oxyaster. In an oxyaster there are more than five rays as in *Stelleta brevis* (Hentschel)¹ with six and *Stelleta phrissens* with numerous rays. Sollas has figured oxyasters in *Epallax callocyathus* with four rays, and also forms which can be well described as microcalthrops and microxea. Similar examples are *Anthastra pulchra* and *Anthastra communis* but with this difference that the rays are rough. *Anthastra pulchra* and *Anthastra parvispicula* (Sollas)² show a number of stages in which the rays get reduced in number and a typical oxyaster gets reduced to a calthrop, a triod or a microxea. Typical examples of oxyasters with roughened rays are found in *Geodia punctata* (Hentschel).³

If the rays of such oxyasters become swollen as happens in *Donati ingalli* (Dendy)⁴ or *Donati fissurata* (Hentschel),⁵ we get a stylaster with smooth rays in the first, and roughened rays in the latter form. From the oxyaster can be derived the spheraster in which the rays are thickened and a centrum is well

¹ Hentschel, *Trans. S.W. Aust.*, 1909, p. 357.

² Sollas, *Challenger Report*, Vol. XXV, Pts. 12 and 13.

³ Hentschel, *Trans. S.W. Aust.*, 1909, p. 368.

⁴ Dendy, *Trans. Linn. Soc.*, Vol. XVII, 1916, p. 264.

⁵ Hentschel, *Fauna S.W. Aust.*, 1909, p. 376.

developed. The rays may be smooth or rough. In some cases as in *Donati fissurata* (Hentschel, *ibid.*). The rays may be branched. Instances of oxyasters with profusely branching rays are seen in *Xenospongia patelliformis* (Dendy).

As has been said above, due to a reduction in the number of rays of an aster one may arrive at diactinal forms which have been described as microxea and microrhabds and which may be either smooth or rough. Instances of such reduction are seen in *Epallax* and *Anthastra* quoted above. Such diactinal forms cannot be assigned to the sigmatose group, but must be regarded as astrose types.

In 1916, Dendy has described the development of a spicule which he called Sterrospheraster found in *Aurora rowi* (Dendy).¹ I cannot do better than reproduce the original description:—

‘The full-grown spicule is spherical, with a very large, solid centrum whose surface is covered with close-set, irregular, flattened protuberances, incompletely separated from one another by narrow grooves which form a reticulate pattern. The development of this spicule is very interesting. The first stage is a slender-rayed oxyaster, but apparently the rays may sometimes be truncated. A distinct centrum is then developed between the basal portions of the rays, and the whole spicule at the same time increases in size. As the centrum grows larger the rays grow longer and increase in number. As growth proceeds the rays begin to thicken and become bluntly conical. The radius of the centrum is now growing more rapidly than the length of the rays, so that the intervals between the latter become to a large extent filled up, the ends of the rays forming blunt conical projections on the surface of a sphere. Short spines are now developed at the end of the rays. The spheraster has now reached what appears to be the adult condition in *Aurora* (*Stelletta*) *Aurora* (Hentschel, 1909). The adult condition in our species appears to be arrived at by further development of the terminal spines and by their fusion with one another to form the enlarged extremities of the rays, and with those of adjacent rays to form bridge like connection between these extremities.’

This spicule in its fully developed form is scarcely distinguishable from the sterrasters of the family Geodidæ the most complex of the astrose microscleres. The development of a sterraster has also been worked out by Dendy in *Geodia auroristella*. The fully formed sterraster is a solid mass of silica usually of an ellipsoidal form the surface of which shows star-like projections set very close together. The development of this spicule shows that it arises from a very small aster with a number of slender rays. The rays increase in size and as they grow the interval between them gets reduced and filled up with

¹ Dendy, *Trans. Linn. Soc.*, Vol. XVII, 1916, p. 249.

silica the ends of rays become enlarged and finally appear as star-like projections on the surface. On one spot these are absent and this is known as the hilum which according to Sollas marks the position of the nucleus of the 'Mother' cell in which the spicule is developed. These are found generally on the surface and unlike other microscleres they serve the function of supporting the sponge body. Another spicule which is characteristic of Erylidæ is the Aspidaster which in its mature form consists of an oval disc of silica with an umbilical pit. The development of this has been worked out in detail by Lendenfeld in his work on the Erylidæ. It begins as a delicate oval aster in which the rays are delicate and greatly elongated, radiating from a centre. 'The rays which in this young stage appear to be isolated throughout grow in length and in thickness. Their longitudinal growth leads to an increase in the size of the aspidaster their transverse growth or thickening to a coalescence of the rays themselves which as the growth continues progress from the centre to the margin of the disc. Thus the aggregation of isolated radial rays becomes larger solid discs with serrated margins. This goes on till the spicule has attained its normal size. Then the longitudinal growth of the rays ceases while their lateral growth continues. This leads to a filling up of the serrations and to the formation of smooth discs with more or less continuous margins'.¹ It is clear that Aspidaster also is an evolved form of the simple aster.

Coming now to a consideration of the diact or sigmatose series we find that their starting point is the toxon, a simple diactinal angulated spicule as seen in *Gellius angulatus* (Dendy) and *Clathria encrusta* (Kumar).² So long as the angle remains wide this spicule resembles the diactinal forms found in Plakinidæ. The angle of the toxon however becomes more acute as the two rays approach one another, and we get forms of toxa as found in *Artemisina erecta* (Topsent).³ This ultimately results in the formation of true forceps or labis as seen in *Forcepia arenosa* (Hentschel),⁴ *Clinolabis dentifera*, *Leptolabis forcipula* (Topsent).⁵ The rays may be smooth or they may be echimated either throughout or towards tips only. In these forms the ends of the rays are in a number of cases enlarged into small knobs. In many instances the two rays of a toxon do not lie in the same plane but exhibit a spiral twist.

If in a simple toxon the two rays show different curvature it gives rise to, in fact becomes, a sigma which shows a very large number of variations. If the rays of a toxon instead of

¹ Lendenfeld, *Mem. of the Mus. of Camp. Zoology*, 1910, Vol. XLI, p. 306. *Camp. Zoology*, Pt. 7.

² Kumar, *Rec. Ind. Mus.*, Vol. XXVII, p. 221.

³ Topsent, *Spong. des Açores*, Vol. XXV, 1904, Pt. XV.

⁴ Hentschel, *Fauna S.W. Aust.*, 1911, p. 339.

⁵ Topsent, *Res. Campg. Sci. De. Monaco*, Vol. 74.

pointing outwards point inwards, the spicule becomes C-shaped and if in addition there is a spiral curvature, the spicule appears C- or S-shaped according to the angle of observation.

In the genus *Tetilla* the spiral twist of the sigmata is very pronounced as is also the case with a number of other species like *Rhabderemia minutula* (Topsent),¹ *Stylostichon repens* (*ibid.*, plate 14). And Dendy mentions that its extreme condition is reached in the spicules of *Trachycladus lavispirulifer*. The chiasmata is a peculiar form, the origin of which is difficult to explain. It has been figured by Topsent in *Myxilla pecqueryi*² and *Leptosia schmidtii*.³ It consists of two curved rods crossing each other at right angles, the free ends being knobbed.

In *Esperella* (*Mycale*) *simonis* there occurs a thick sigma with ends curved inwards and somewhat flattened. This forms according to Dendy a transition between the simple sigma and that very peculiar spicule called diancistrum, so characteristic of the genus *Hamacantha* the development of which has been worked out by Lundbeck in the case of *Hamacantha bowerbanki*. In this we see differentiation of the sigma into a shaft, teeth and the fimbriæ, which play such an important part in the evolution of the chelate forms, making their appearance for the first time.

Kirkpatrick⁴ discovered in *Merlia normani* a spicule which he calls the clavidisc, or the key-hole spicule. This spicule begins as a simple sigma in which the two ends meet and then are fused to form a ring. From the inner margin of this ring arise fimbriæ which extend inwards in the median plane and are notched at either end of the oval disc.

Kirkpatrick has also described another form of spicule which he calls the canonochela found in *Cercidochela lankesteri* (Kirkpatrick).⁵ When fully developed it consists of an oval ring from the inner sides of which arise 4 fimbriæ, 2 elongate and large and 2 small and semi-circular. This form also develops as a C-shaped sigma whose ends meet and fuse to form an oval ring from which fimbriæ are developed asymmetrically.

A very peculiar type of microscleres the relationships of which are difficult to establish, are the bipocelli and tetrapocelli. A typical bipocellus consists of a curved shaft the ends of which are expanded into shallow basin-shaped fimbriæ as seen in the bipocelli of *Guitarra bipocellifera* (Brondsted).⁶ In the bipocelli

¹ Topsent, *Spong des Acores*, Vol. XXV, 1904, Pt. 13.

² " *Res. Campg. Sci. Monaco*, Fasc. II, p. 110, 1892.

³ " *Spong des Acores*, Vol. XXV, 1904.

⁴ Kirkpatrick, *Q.J.M.S.*, Vol. 56.

⁵ Kirkpatrick, (*Nat. Ant. Arctic Expedition*, Vol. 4, Nat. Hist.).

⁶ (a) Brondsted, Papers from Dr. Th. Mortenson's Pacific Expedition, 1914-16, Vol. XXIII. Sponges from New Zealand, Pt. 1, p. 459.

(b) Brondsted, Papers from Dr. Th. Mortenson's Pacific Expedition, 1914-16. Sponges from New Zealand, Pt. I, p. 457.

of *Iophon chelifer* the fimbriæ at one end are divided into three teeth whereas at the other end they are bifurcate.

Bowerbank¹ in his monograph of the British Spongida has figured certain spicules which he calls the Inequi-trirotulati and eccentric trirotulati. Brondsted who was ignorant of Bowerbank's figures has re-discovered the same spicules in his sponges, from New Zealand and proposes the name tetrapocelli. Brondsted's description is far more complete and the name proposed by him for these spicules more appropriate. I therefore give below a summary of Brondsted's description. Tetrapocelli are the characteristic microscleres of the genus *Tetrapocillon* (Brondsted, *ibid.*, page 457).

In the young stages they consist of a cylindrical shaft with 2 semi-circular parts, appearing as if they were 2 separate pieces cemented together but really being one piece. Later both ends expand to form plates and 2 plates are formed in the middle of the shaft which are at first separate and later on fuse together at their outer rims. In the fully grown spicules the rims of all the plates grow obliquely inwards as fine lemmellæ and convert these plates into shallow saucers, in pairs. The hollow of a pair pointing towards each other. They may be compared to 2 bipocelli which have been fused together end to end. Judging from Brondsted's account it is probable that these also are modified sigmas.

The chelæ are one of the most remarkable of sigmatose microscleres and are most commonly met with in Desmacidonidæ. These are palmate or dentate, iso or anisochelæ. In the palmate chelæ the two ends of the curved shaft are greatly complicated by the presence of leaf-like structures at each end. A typical palmate isochela consists of a curved C-shaped body the more or less straight part is called the shaft and the free ends of the C are the teeth. From the shaft towards each end there arise 2 flat delicate plate-like structures each of which individually is called the fimbriæ and the two together the alæ. From the free ends of the C-shaped body there arise similar structures also called the fimbria and the two together are called the fluke. A portion of the spicule remaining unexpanded between the fluke and the alæ is known as the flax. If the two ends of a chela as described above are similar, it is termed Isochela, if dissimilar, Anisochela, whether it is palmate or dentate. The evolution of Chelæ from simple sigma is now recognized by all spongologists and Lundbeck² has worked out the development of the palmate isochela in *Esperiopsis villosa*. The young chela in *Esperiopsis villosa* is a simple sigma with long incurved ends. From the free ends of the young spicule and from the

¹ Bowerbank, A monograph of the British Spongiadæ, Vol. I, 1884, Pt. X.

² Lundbeck, Danish In-golf Expedition, 1905, Vol. VI, Pt. 8.

lower ends of the shaft arise the delicate expansions called fimbriæ which give rise to the alæ and the flukes and result in the formation of a palmate isochela.

Further modification may result by the flax giving out a thin expansion between the flukes; the alæ and the tooth being reduced to a mere tubercle. As in the course of evolution the fluke becomes well established, we notice that it undergoes further changes and begins to behave as an independent unit showing meristic variations and we get several species in which chelæ show a number of flukes at each end, varying from 1 in *Esperiopsis*, *Esperella*, and *Guitarr* to 12 in *Iotrochota*. Each fluke in such cases develops its own tubercle and flax. The commonest variation of this type shows 3 such flukes and the spicule is then called tridentate. In *Myzilla diversianchorata* (Lundbeck)¹ there are 5 to 8 teeth. According to Dendy, 'The mode in which flukes arise appear to be by progressive differentiation and separation from the shaft of the thickened bases of the alæ or lateral palms'.

This process of addition of flukes and teeth is seen in *Iotrochota* and the ultimate result is the birotulate or amphidisc of *Iotrochota lubria* (Lundbeck, *ibid.*) which has an extraordinary superficial resemblance to the amphidiscs of Hexactinellids.

The most remarkable type of chelæ known is the sphærancora of the genus *Melonanchora* the development of which has been worked out by Lundbeck.² In its earliest stages the spicule begins as a tridentate isochæla devoid of any fimbriæ. The teeth at each end grow and meet each other near the middle of the spicule and thus we get to a stage where the spicule consists of four meridional arcs. One of these being the original arc, the other three the elongated and fused teeth. Each arc now thickens and from each arc there grows inwards a pair of fimbriæ which are striated radially giving rise to the peculiar sphærancoræ.

In both mega- and microscleres development of spines is very commonly observed. These spines are a secondary growth and give rise to very curious results. In some cases the spines so formed assume the dimensions of actines or rays and thus there arise what are known as the pseudopolyact type of spicule. The spines on a spicule can generally be distinguished from true rays by the fact that the latter meet at the organic centre of the spicule whereas the spines do not.

The development of spines on an oxeote gives rise to acanthoxea as seen in *Grayella spinulata* (Hentschel)³ and *Agelas axifera* (Hentschel).⁴ By the reduction in size of such acanthoxea

¹ Lundbeck, Danish In-golf Expedition, 1905, Vol. VI, Pt. 15.

² Lundbeck, Danish In-golf Expedition, 1905, Vol. VI, Pt. XX.

³ Hentschel, *Fau. S.W. Aust.*, 1911, p. 341.

⁴ Hentschel, *Fau. S.W. Aust.*, 1911, p. 392.

pseudasters are sometimes produced as in *Yvesia alecto* (Topsent)¹ and *Spongilla fragilis* (Potts). And again in *Dosilia plumosa* (Annandale)² we find pseudasters of a different type which according to Dendy are reduced acanthoxea. The formation of spines at the two ends of the spicule gives rise to the birotulate and amphidisc gemmule spicules of many spongilidæ, e.g. in *Ephydatia*, *Dosilia*, and *Corvospongilla* (Fauna, British India). Similarly strongylote forms may also be spinated.

In monactinial forms the development of spines on the spicule gives rise to the acanthostyle as in *Raspailia anastomosa* (Kumar).³ The nature of spines may vary, they may be large or small, straight or curved and either uniformly spread over the entire body of the spicule or restricted to one place leaving the rest of the spicule perfectly smooth.

Topsent⁴ has figured an acanthostyle in *Hymenophria spinispinosa* in which the base has assumed the shape of an aster and according to Dendy by a gradual reduction of the shaft accompanied by an enlargement of the base of the spicule, pseudasterose forms may result as in *Leptosastra constellata* (Topsent).⁵

In *Cyamon vickersii* we find a pseudopolyact spicule which is a megasclere. Dendy⁶ has traced the entire growth of this spicule. The youngest stage is a small acanthostyle with a smooth shaft and 2 or 3 spines arising from the base. These basal spines grow more rapidly than the shaft and ultimately attain the same dimensions as the shaft itself. At this stage a thickening of all branches takes place and they are further ornamented by secondary spines so that in a fully grown spicule it is almost impossible to say which branch is the original shaft and which are the developed primary spines. These pseudopolyact spicules may be like megacalthrops, or triods or even like diactines.

In the above instance we noticed that the modified spicule resulted from the enlargement of spines at the bases. It may happen that a similar enlargement and localization of spines takes place towards the apex of a monact spicule. According to Dendy this process is foreshadowed in *Raspailia thurstoni* where the apical spines are considerably larger than the rest and the head is perfectly smooth. In the genus *Acarnus* we find two species one *Acarnus topsenti* with grapnel spicule in which there is a whorl of large spines at the apex, and another small one at the base; and the shaft also possesses small spines.

¹ Topsent, *Spong. De. Acores*, 1904, Vol. XXV, Pt. 15.

² Annandale, *Fau. Bri. Ind. Sponges*.

³ Kumar, *Records of the Indian Museum*.

⁴ Topsent, *Spong. De. Acores.*, Vol. XXV, 1904, Pt. 14.

⁵ Topsent, *Spong. De. Acores.*, Vol. XXV, 1904, Pt. 15.

⁶ Dendy, *Trans. Linn. Soc.*, Vol. XVIII, 1921, p. 194.

The other *Acarnus ternatus*¹ has three large spines bent backwards, the shaft is smooth and the base is enlarged into a knob. This spicule has the exact appearance of an anatriaene.

Spines make their appearance on the microscleres as well. Spines are found on the sigma of *Paresperella*. Topsent has recorded cases of sigmata which are ornamented with spines. In *Craniella disigma* (Topsent)² in addition to the ordinary sigmata there are larger forms which possess a row of spines along the margin. In *Chrotella amphiacantha* (Topsent),³ the main body of the sigma is smooth but the ends are decorated with 3 or 4 spines. In *Lissodendoryx indistincta* we find spicules which Lundbeck⁴ has described as spined chela. These resemble the spined sigmata of the species referred to above with the difference that towards their free ends they show 3 or 4 teeth-like spines grouped together. Whether they are true chelæ is doubtful and in all probability they are spined sigmata which on account of the spines at their ends have become cheloid in appearance. So much for the spination of the sigma. Chelæ also may acquire spines and this is seen beautifully in the tridentate chela of *Hymedesmia crux* (Lundbeck)⁵ which possesses spines on the outer margin of the shaft near the middle. This spination is seen in *Pseudohalichondria clavilobata* (Carter) and Topsent⁶ has given figures for the isochelæ of *Leptosia schmidtii*, *Leptosiopsis inequalis*, and *Acanthancora clavatanancora* in which the spines are numerous and give rise to very irregular forms. In *Hymedesmia ænigma* (Lundbeck)⁷ spines begin to branch and as the spicule is twisted, the end view of the spicule has the appearance of a pseudaster. The extreme of this process is to be met with in *Hymedesmia vidua* (Thiele) 1903, where the chela becomes a typical pseudaster.

We must now turn our attention to another category of spicules called the discorhabds or the spectrella spicules of the *Spiraestrellinæ* and their derivatives. For a long time these spicules have been regarded as belonging to the astrose type and were known as discasters and spirasters. Vosmaer however pointed out as far back as 1902 that these were not true asters but modified monaxon spicules. Dendy⁸ has described the origin of the discorhabds in *Didiscus placospongioides*. In this the 'young spicule is a small fusiform diact sharply pointed at each end'. At a certain stage of 'its development two silicious

¹ Ridley, Alert Report, 1884, p. 454.

² Topsent, *Spong. De. Acros.*, Vol. XXV, 1904, Pl. XI.

³ Topsent, *Spong. De. Acros.*, Vol. XXV, 1904, Pl. XI.

⁴ Lundbeck, *Danish In-golf Expd.*, Vol. VI, 1905, Pl. XVI.

⁵ Lundbeck, *Danish In-golf Expd.*, Vol. VI, 1910, Pt. 8.

⁶ Topsent, *Res. Campg. Sci. Monaco.*, Vol. LXXIV, 1928, Pt. IX.

⁷ Lundbeck, *Danish In-golf Expd.*, Vol. VI, 1910, Pt. 9.

⁸ Dendy, *Trans. Linn. Soc.*, Vol. XVIII, 1921, p. 135.

discs or whorls make their appearance one near the middle and the other to one side of it. The discs thicken and become saucer-shaped and the shaft thickens and develops spines.' The fully developed spicule does not lose its oxeote nature and is called by Dendy Oxydiscorhabd. The typical chessman spicule is found in *Latrunculia*. It is also called anisodiscorhabd as its two ends are asymmetrical. They vary in shape but always have a base and an apex and are characterized by siliceous whorls of varying sizes and shapes along the body. The base is known as manubrium and the apex is differently modified. *Latrunculia multirotalis*¹ and *L. insignis*¹ show good examples of this type. Dendy has worked out the development of anisodiscorhabd of *Latrunculia bocagei*. In this the spicule begins 'as a simple slender rod' and later thickenings make their appearance either at one or both ends. These thickenings then develop into whorls of silica. The spicule itself becomes considerably enlarged and thickened resulting ultimately in the adult anisodiscorhabd. Another discorhabd is the isodiscorhabd. In the adult stage it consists of a long thick axis with generally whorls of spines along the shaft and one at each end. The whorls consist of lobes varying in number usually 3-4 and subdivided into spines. The development of this spicule was first worked out by Dendy² and later in greater detail by Topsent,³ in *Podospongia loveni*. According to the latest work of Topsent this spicule begins as a slender rod with a slight angulation in the middle. The next stage in its development shows its two ends curving inwards and the spicule acquires a sigmoid form. It now begins to thicken and spines make their appearance. The first two are on the shaft on each side about half way. The next stage shows other spines at the angles and the free ends of the sigma. The spicule now thickens considerably; the sigmoid form is altogether lost and the adult spicule appears as a thick, almost straight rod with the spines consisting of two whorls on the body and two terminal whorls. The only indication in the adult spicule of its passage through a sigmoid stage is the persistence of the original torsion in the alternation of the lobes of the whorls. Dendy who was not aware of the pre-sigmoid stage in the development of isodiscorhabd proposed to alter its name to sigmodiscorhabd, but in view of Topsent's work one is not quite sure if this change would be justified.

We now come to the spinispiræ which are so characteristic of the genus *Spirastrella*. These according to Dendy are reduced isodiscorhabds, a fact which was also pointed out by Carter as long back as 1879 in the case of *Latrunculia corticata*.

¹ Topsent, *Result Campg. Sci. Monaco*, Vol. LXXIV, 1928, Pt. 7.

² Dendy, *Trans. Linn. Soc.*, Vol. XVIII, 1921, p. 137.

³ Topsent, *Bull. de Ins. Oceanog.*, 1922, p. 7, and *Result Campg. Sci. Monaco*, Vol. LXXIV, 1928, Pt. 7, fig. 17a.

The spinispiræ by their reduction in size and modification of shape give rise to pseudasters as in *Timea curvistellifera* and *T. stellivarius*. *Sterrospira* of the genus *Placospongia* is worthy of note. This is a most remarkable modification of the spinispiræ. In adult condition they have such striking resemblances to the sterrasters of the genus *Geodia* that Sollas included *Placospongia* in the group *Sterrasterosa* side by side with the family Geodidæ in spite of the fact that triænes were absent and tylostyles present as megascleres. Vosmaer and Vernhaut¹ in their monograph on the genus *Placospongia* (1902) have shown conclusively that the *Sterrospira* develops from a spinispira and are not true asters at all but pseudoasters.

Branching of the primary rays in a tetract spicule has already been noticed. In the discotriæne and philotriæne a similar process of branching of the rays gives rise to the peculiar spicule of Lithistid sponges which are called the desmas. These have been divided up into two categories, the tetracrepid and the monocrepid. The young rudiment of the spicules is known as 'crepis'. In the former the 'crepis' is a primitive tetract and in the latter a diact or monaxonid. A third type of desmas is known which has been called by Sollas 'acrepidal' and this also occurs in the Lithistids. In acrepidal desmas the number of primary rays vary and arise from a thickened centre, whereas no 'crepis' is visible. The desmas, therefore, has been regarded as polyphyletic in origin. The common characteristic of desmas however is that they branch repeatedly and the ultimate branches are often thickly clustered and knobbed. These knobs form articulating processes by means of which the neighbouring desmas become interlocked, giving rise to a very hard sponge skeleton.

As has just been noted above the Lithistids are to be regarded as polyphyletic in origin and according to Dendy one possible ancestor of the Lithistids is to be looked for in that peculiar sponge called *Crambe crambe*.

We have traced so far the apparent lines of evolution and we have seen from the ontogenetic development of individual spicule that the most highly specialized forms actually develop from simple forms well known in less advanced species. The discotriæne of *Discodermia* begin as a tetract, as also the tetracrepid desmas, the sterrospheraster and sterraster commence as spherasters. The sterrospira of *Placospongia* indistinguishable in the adult form, from the sterrasters of *Geodia* really begins as a spinispira characteristic of Spirastrellidæ. The oxydiscorhabd is a simple diact spicule in origin. The chela are modified sigmata. The diancistra, the clavidisc and cannonchelæ in their earliest stages are sigmata and the extraordinary sphærancore develops from a chela, the isodiscorhabd

¹ Vosmaer and Vernhaut, Siboga Exped. Report, VIa, 1902.

also passes through a cheloid stage though so very different to it in the adult, and last but not the least the polyact megascleres of *Cyamon* can be traced back during their individual development to acanthostyles. If, as I have said already, the real object of classification is the arrangement of forms in accordance with their affinities, it will be clear that the sponge spicule has a very great taxonomic value. As a matter of fact spongologists have long been of opinion that in classification spiculation should have the first place among all other characters. But the great difficulty with which workers are faced is the very frequent occurrence of the phenomenon of convergence in sponge spicules. This is best seen in the development of pseudasters over and over again among the sigmatotetraxonids. We have seen how pseudasters indistinguishable from true asters arise from oxea, styli and spinispira. We have seen also how diactinal microrhabds have arisen from true polyact asters. These phenomena have often caused errors in classification. To quote one instance Sollas placed the genus *Placospongia* near the Geodidæ because of the resemblance of sterrospira to the terrasters, and it was only recently that Dendy in 1922 has transferred the entire sub-family Spirastrælline from Astro- to Sigmatotetraxonida because the so-called 'discasters' (discorhabds) and spirasters (*Spinispira*) are not true asters but modified monaxons.

Another difficulty with which the taxonomist is faced is the simplification which results in spiculation by the dropping out of entire spicule categories and this often leads to convergence and the establishment of polyphyletic groups. The so-called family Epipolasidæ is characterized by the absence of triænes and is probably a heterogeneous collection of Stelletids from which triænes have dropped out. The genus *Chondrosia* is another instance where the entire spiculation is lost and the sponge has come superficially to resemble the primitive Myxospongid *Oscarella*. To quote one more instance the common and well-known genus *Halichondria* is a reduced form without tetract megascleres or any microscleres, but it cannot yet be said whether it is a reduced Astro- or Sigmatotetraxonid, and similarly Suberitinæ and Clioninæ are reduced forms.

Coming now to the classification of Porifera, Gray was the first to point out the broad distinction of the phylum into two subdivisions which he named Porifera Calcarea and Porifera Silicea. Vosmaer¹ recognized this division as just, but objected to the term Silicea as misleading and substituted for it 'Non-calcarea'. Polejaeff² also recognized the independence of Calcarea as a class. Sollas in 1884 suggested the name Plethospongia for Porifera Non-Calcarea, but dropped it soon after.

¹ Vosmaer, Report on sponges dredged by William Barents, 1882.

² Polejaeff, Challenger Report, 'Calcarea', 1883.

Relying however on the observations of Haeckel that the choanocytes of Calcarea were generally larger than those of Non-Calcareous sponges, Sollas¹ in 1886 proposed the two names *Megamastictora* and *Micromastictora* for Calcarea and non-Calcarea respectively. Vosmaer divided the non-Calcarea as follows :—

Class : Porifera non-Calcarea (*Micromastictora*)—

Order I.—*Hyalospongæ* (*Hexactinellida*).

Order II.—*Spiculispongia* in which skeleton consisted of independent spicules or was only rarely absent.

Order III.—*Cornucospongia* in which skeleton consisted of monaxons cemented together by spongin or of spongin only.

Lendenfeld classified them as follows :—

Sub-class : Silicea (*Micromastictora*)—

Order I.—*Hexactinellida*.

Order II.—*Chondrospongæ*, Mesoglea hard. Spicules tetraxon, monaxon, anaxon or absent, generally corticate.

Order III.—*Cornucospongia*, Mesoglea soft. Skeleton with monaxons cemented by spongin or spongin only.

It will be seen that the distinguishing character which Vosmaer employs between *Spiculi* and *Cornucospongia* is the absence and presence of spongin. This distinction was not absolute as several sponges included within the former possessed a certain amount of spongin. Apart from this the species of sponges belonging to the two orders pass so gradually and insensibly one into the other that a sharp line of distinction was impossible as between the *Hexactinellida* and the remainder.

With regard to Lendenfeld employing the additional characters of mesoglea Sollas rightly observed 'that as a distinctive character it has absolutely no value' nor could the *Chondrospongia* be regarded as 'generally corticate'.

To meet these objections Sollas proposed the following classification :—

Class I.—*Megamastictora* (Porifera calcarea).

Class II.—*Micromastictora* (P. non-Calcarea).

Sub-class I.—*Myxospongia* askeletose.

Sub-class II.—*Hexactinellida*—with triaxon spicules.

Sub-class III.—*Demospongia* (Sollas) skeleton of Siliceous spicules or spongin or both.

Megascleres never triaxon.

¹ Sollas, *Zoological Record*, Vol. XXII, 1886, p. 13.

The sub-class Demospongiæ proposed by Sollas, he further sub-divided into two tribes, Tetractinellida, a name first proposed by Marshall and later adopted by Zittel and others and Monaxonida. The Monaxonida were divided into Monaxona, i.e. with spicules and with or without spongin and Ceratosa without spicules and with spongin. Sollas included the Ceratosa in Monaxonida as he considers them as being admittedly descended from the Monaxona.

Minchin in Lankester's Zoology, 1900 divides the sponges into 3 classes, viz. Calcarea, Hexactinellida, and Demospongia. In other words, he splits the non-Calcarea into 2 classes of equal value. He further divides the Demospongiæ into 4 sub-classes of equal value, viz. Tetraxonida (proposed by Lendenfeld), Monaxonida, Ceratosa, and Myxospongida.

In 1905, Dendy divided the non-Calcarea into 4 orders of equal value and called them Myxospongiidæ, Triaxonida, Tetraxonida, and Euceratosa.

He defined the Myxospongida as non-Calcarea which are primitively destitute of spicules and horny fibres with simple canal system and he regards this order as representing the common starting point, from which have originated the Triaxonida the Tetraxonida and Euceratosa and he does not 'agree with Minchin in placing Myxospongida at the end of the siliceous series instead of at the beginning'. His Triaxonida is the same as Hexactinellida but the Tetraxonida is used in a much wider sense than that employed by Minchin.

The Euceratosa are non-Calcareous sponges without siliceous spicules but with a skeleton consisting of horny fibres developed independently, i.e. not in relation to any pre-existing spicular skeleton.

Tetraxonida were defined as non-Calcarea in which the fundamental form of the spicule is tetraxonid and tetractinellid. This fundamental form is often obscured by secondary modifications and the spicules may even disappear completely as in some degenerate forms or may to a certain extent be replaced by spongin. This order tetraxonida was sub-divided in 1905 as follows :—

Grade Tetractinellida :

S.O. Homosclerophora.

S.O. Astrophora (Sollas).

S.O. Sigmatophora (Sollas).

Grade Lithistida.

Grade Monaxonellida :

S.O. Astromonaxonellida.

S.O. Sigmatomonaxonellida.

The Astromonaxonellida were regarded as being derived from Astrophora and Sigmatomonaxonellida from Sigmatophora.

Hentschel (1909 and 1911) substantially accepted this view

of Dendy with regard to the phylogeny of Tetraxonida but suggested the following modification. He divided the order Tetraxonida directly into 3 sub-orders, viz. :—

S.O. Homosclerophora (Dendy).

S.O. Astrotetraxonida (Hentschel)=(Astrophora + Astromonaxonellida).

S.O. Sigmatotetraxonida (Hentschel)=(Sigmatophora + Sigmatomonaxonellida).

Dendy¹ accepted this modification proposed by Hentschel in his report on the 'Sealark sponges' (1916 and 1921). He also agrees with him in maintaining the Lithistida as a fourth sub-order. He however disagreed with Hentschel in including the Ceratosa amongst the Tetraxonida, but gives them the rank of an order under the name of Euceratosa excluding all such genera as appear to have originated from Tetraxonid forms by the suppression of spicules and giving the name Pseudoceratosa to such forms, so long as the origin of individual species remains unworked out.

This appears as near an approach to a natural classification as possible and to quote the words of Dendy 'we are thus, I hope, finally rid of the old and artificial distinction between Tetractinellida and Monaxonida introduced by Zittel (1878), which the Challenger Reports unfortunately did so much to emphasize'.

¹ Dendy, *Trans. Lin. Soc.*, 1916 and 1921.

Section of Zoology.

Abstracts.

1. Ecological studies of Pink Bollworm (*Platyedra gossypiella* Saunders).

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The Pink Bollworm is a serious pest of cotton in certain parts of the Punjab and negligible in others. The differences in attack are due to the differences in climate which greatly affect its procreation. The latter is much higher in places of high incidence than in places of low incidence.

It has been established that temperature and humidity acting on both the pupæ and the adults influence egg-laying. The most favourable temperature for the development of gonads and the deposition of eggs lies between 75°F. and 82°F. and of humidity from about 70 to 95%, while the moths emerging from the pupæ kept at 92°F. or above are devoid of fully developed sperms.

The data collected further show that oviposition under natural conditions was highest when the mean maximum temperature acting on the pupæ and the adults was about 90°F., mean minimum 72°F. and the relative humidity 70% or more at 8 hours.

On the basis of these results it is possible to predict the incidence of Pink Bollworm at any place. In places where the pest becomes active at the time of the fruiting of cotton and the climatic conditions are favourable for its oviposition it will be serious but not in others.

2. On the bionomics and distribution of *Herdmania pallida* Lahille (*Rhabdocynthis pallida* Herdman).

S. M. DAS, Lucknow.

The genus *Rhabdocynthis* has, according to the law of priority, been re-named *Herdmania* by the author. It is studied as a type of the Tunicata in almost all Indian Universities instead of the European genera *Ciona* and *Ascidia*. Our knowledge of *Herdmania* has hitherto been very meagre and incomplete; in fact, little work was done on any Indian ascidian since Herdman's visit to Ceylon in 1906.

The following is a summary of the author's investigations into the bionomics and distribution of this typical Indian mon-ascidian:—

The animal is found in the Gulf of Manaar at a depth of 5–12 fathoms extending as far as 10 miles from the sea-shore. The animal has also been reported from the Indian, Pacific and Atlantic Oceans and from the Malayan Seas and the West Indies.

The bed harbouring *H. pallida* has been called a 'chank-polychæte formation,' as the association between the three animals is almost constant.

It is a solitary animal and is usually found in groups of 10–12 individuals. It remains attached to the substratum by a 'foot' formed by the test; it is often found attached to shells of living chanks (*Turbinella pyrum* and *T. rapa*) and in such cases the association offers a typical example of commensalism.

The food consists mainly of diatoms, algæ, and infusorians.

Besides the constant ciliary water-current passing through the body, the animal takes to voluntary regular contractions of the body and siphons at intervals, which serve as aids to respiration.

H. pallida is hermaphrodite and oviparous.

3. On the external characters of *Herdmania pallida*.

S. M. DAS, Lucknow.

A description of the external characters of mon-ascidians is important as in most systems of classification, the external characters form an important criterion for the identification of species.

The following is a summary of the chief characters noted :—

The body is oblong or pear-shaped, about $9.5 \times 7 \times 4$ cms. in size, with a foot about 3.4 cms. long, which remains imbedded in the sand. The foot is absent when the animal is attached to a hard surface.

The colour of the body is distinctly reddish on account of bright red patches in the test formed by the red-pigmented knobs of the blood-vessels. Herdman's (1891) description of the colour of *H. pallida* has been revised and corrected.

The test is more or less transparent in young animals but usually becomes opaque in the adult.

The branchial and atrial apertures are both 4-lobed, the atrial aperture being almost upright and the branchial always somewhat lateral.

The spinules, on which Lacaze-Duthiers and Delage try to base the identification of species in Cynthidæ, are absent from the external surface of *H. pallida*.

4. On the presence of nerve-cells, nerve-fibres, and receptor-cells in the test of *Herdmania pallida*.

S. M. DAS, Lucknow.

This is the first time that structures comparable to nerve-cells and nerve-fibres have been demonstrated in the test of an ascidian. The general test, and more specially the test of the siphons, is very sensitive and contracts on a slight disturbance of the water in which the animal lies. A pin-prick on the test of any of the two siphons causes an immediate contraction of that siphon. This suggested the possibility of the nervous tissue being present in the test to enable the animal to feel the prick. The nerve-cells and fibres were discovered after staining with methylene blue and methyl-blue eosin. The cells lining the vascular ampullæ, present in the test near its outer surface, have a special supply of fine nerve-fibres and act as receptor-cells. Some receptor-cells are also found scattered in the superficial layers of the test. All the nerve-fibres ultimately join the nerves emerging from the nerve-ganglion.

5. On the mantle and the atrial cavity of *Herdmania pallida*, with a note on the rôle of the muscles in producing movements in the animal.

S. M. DAS, Lucknow.

The mantle of Tunicata, enclosing the large atrial (or peribranchial) cavity, is the body-wall proper of the animal lying just beneath the test. Herdman (1906) gave a short account of the mantle of *H. pallida*, but he makes no mention of the form, structure, arrangement, and particular function of the different sets of muscles.

The results of the present investigation may be summarized as follows :—

The mantle consists of an outer ectoderm of squamous epithelium, a middle layer of parietal mesoderm and an inner ectoderm that lines the atrial cavity.

The outer ectoderm is turned in right down to the base of the 2 siphons forming a stomodæum and a proctodæum.

The muscles of the mantle, confined to the antero-dorsal half of the body, control the different movements of the animal which are described. The muscles can be arranged into (a) the branchial group, (b) the atrial group, and (c) the branchio-atrial group. Besides these a strong sphincter muscle is present at the base of each of the two siphons, which can close the internal siphonal aperture.

The atrial cavity is divided into a right and a left half due to the fusion of the branchial sac with the mantle along the midventral line of the body; but the two halves are continuous dorsally.

6. On the spicules found in the test and the mantle of
Herdmania pallida.

S. M. DAS, Lucknow.

Herdman (1885) gave a description of calcareous spicules in Tunicata and later (1891) founded the genus *Rhabdocynthis* (*Herdmania*) on their presence. He mentions only two types of spicules—the knob-headed and the spindle-shaped varieties. The author has found a third variety—the pipette-shaped spicules—which seems to have been overlooked by Herdman. Mention has been made of the spicules tending to run in ensheathed bundles—a character constant in the last two types of spicules. The spicules are all of the echinated variety.

The spicules have been classified by the author, according to their size, into megascleres and microscleres—the former found in the mantle and walls of blood-vessels and the latter in the test only. The character of the megascleres to pierce almost every organ of the body, except the heart, had not been observed so far.

7. On the neural gland, nerve-ganglion, and dorsal tubercle
of *Herdmania pallida*.

S. M. DAS, Lucknow.

In both *Ascidia* and *Oiona*, the accounts of which are used in Indian Universities while dissecting the form *Herdmania*, the nerve-ganglion is dorsal to the neural gland, which again is situated dorsally to the ciliated tubercle. But in *Herdmania* it is the neural gland that is dorsalmost, and beneath this lies the nerve-ganglion, a condition reverse of that found in *Oiona* and *Ascidia*. The duct of the neural gland opens by a ciliated funnel at the base of the dorsal tubercle which consists of two spirally-coiled conical projections on a broad base. The structure of the neural gland points to an excretory function, while the ciliation and rich innervation of the dorsal tubercle points to a sensory function of this organ. The relation between the duct of a gland (the neural gland, and a pre-pharyngeal sense-organ (the dorsal tubercle) seems to be secondary and purely accidental.

8. On the anatomy and histology of the alimentary canal of
Herdmania pallida, with an account of the digestive
glands and the method of carbohydrate storage.

S. M. DAS, Lucknow.

The present paper, for the first time, gives a complete account of the gut of a Cynthioid, together with an account of the glands of digestion. The much disputed point of the method of carbohydrate storage in mon-ascidians with a liver, has been discussed.

The tentacles are of four different sizes and about 60 in all and not of three sizes and 32 in number as Herdman (1906) mentioned.

The branchial sac has 10 folds on each side instead of 9 as stated by Herdman. Each stigmatic area has 5-6 stigmata and the animal has about 400,000 stigmata in all.

The dorsal lamina has 20-30 tentacular languets.

The endostyle contains four rows of glandular epithelial cells and a median row of cells with very long cilia.

Orton's conclusions about the mode of feeding in ascidians are confirmed.

The oesophagus has four deep grooves through which the food-laden mucus-thread passes in a spirally coiled state into the stomach. The rectal aperture is bounded by four lips.

The 'liver', consisting of a right and a left lobe, is made up of cæca of a single layer of glandular cells and opens into the stomach by several apertures.

The pyloric gland, consisting of tubules ramifying in the wall of the gut and opening by a single aperture into the mid-intestine, seems to be pancreatic in nature.

Carbohydrate is stored in the form of starch-granules found in the liver and in the stomach wall and to less extent in the walls of the mid-gut and oesophagus.

9. On the blood-vascular system of *Herdmania pallida* with an account of the histology of the blood.

S. M. DAS, Lucknow.

The circulatory system of *Ascidia* was fully described by Herdman in 1899 and that of *Polycarpa* by Lacaze-Duthiers and Delage in 1893. But the blood-vascular system of *Herdmania* differs in several respects from that of *Ascidia*, though it resembles that of *Polycarpa* in certain respects.

The following chief features have been recorded :—

The blood contains 7 different types of corpuscles.

The valvular arrangement in the heart is described.

The ventral aorta, the dorsal aorta, the branchio-visceral vessel and the cardio-visceral vessel are the chief vessels. Definite vessels, supplying blood from the heart to the gut and gonads, are described for the first time as also the origin and distribution of the test vessels.

The course of circulation is briefly described together with an account of the periodical reversal of the course of circulation.

10. On the anatomy and histology of the reproductive system of *Herdmania pallida*.

S. M. DAS, Lucknow.

The genital organs of the Cynthiinae had been worked out in some detail by Lacaze-Duthiers and Delage in 1893. But their observations are mainly on some species of *Cynthia*, *Microcosmus* and *Forbesella*, and the descriptions do not hold good for the genus *Herdmania* which is the fourth member of the sub-family Cynthiinae.

The author's findings may be summarized as follows :—

There are two gonads consisting of 10-25 hermaphrodite lobes. Each lobe has a distinct spermatid and an ovarian region.

Each gonad is provided with a vas-deferens and an oviduct.

At least three types of sperms can be distinguished.

Besides the usual layers the ovum of *H. pallida* has an extra-investing membrane which has been called the *inner chorion*. This type of egg is described here for the first time in Cynthiinae.

H. pallida is protogynous. The genital products pass through the atrial siphon (cloaca) into the sea, where fertilization takes place.

11. On two new Monostomes (Trematoda) from Avian hosts in British India.

G. D. BHALERAO, Muktesar.

Two new Monostomes: *Notocotylus babai* from the cæcum of *Mihus migrans govinda*, Rangoon and *Cyclocoelium shavadi* from the thoracic cavity of *Urocissa javirostris cucullata*, Muktesar, have been described. The new species have been compared with the related species of their respective genera. The affinities of the new species with those allied to them are thoroughly discussed. *N. magniovatus* Yamaguti, 1934, has been regarded as synonym of *N. attenuatus*. A key to all the known species of *Notocotylus* from the avian hosts has been given. The status of the various genera so far included in Cyclocoelidæ has been reviewed.

This is the first occasion on which Monostomes are being recorded from this country.

12. A preliminary note on the nephridia and their funnels in the leech *Hirudinaria*.

M. L. BHATIA, Lucknow.

Hirudinaria granulosa, the common Indian leech, is the type dissected in almost all the Universities in India. This leech possesses seventeen pairs of nephridia, metamerically disposed from segments VIII to XXIV, each with a definite external nephridial pore. Hitherto proper attention has not been paid to the structure and disposition of the funnel and preparations made in the laboratories by teachers and students have invariably lacked a funnel. The author has recently been able to make mounts of the funnel from several nephridia in the testicular region. It lies in a blood sinus surrounding a part of each testis. If the dorsal half of a testis sac is mounted, on a slide in a drop of salt solution, from a freshly killed leech, the ciliary movements clearly indicate the presence of the nephridial funnel. The funnel appears as a mass of a large number of horse-shoe shaped cells, which are irregularly arranged and possess rows of cilia upon their free borders. Each horse-shoe shaped cell represents either a separate funnel or probably a lobe of a large crumpled funnel.

13. Gaps in our knowledge of the Indian Protozoa—I. Ciliophora.

B. L. BHATIA, Lahore.

The object of this paper is to survey the Ciliophora so far recorded from different parts of India, and to indicate the provinces from where the records are scanty. Attention is also directed to the families not so far known from India. It is hoped that this will stimulate further research.

14. Gaps in our knowledge of the Indian Protozoa—II. Sporozoa.

B. L. BHATIA, Lahore.

Complete list of the Sporozoa so far recorded from India together with the hosts in which they are known to occur, has been compiled, and it is proposed to publish it later as a check list for the benefit of the medical and veterinary workers and others interested in the subject. Certain gaps in our knowledge of the Sporozoa in India will be pointed out and some problems for future work suggested.

15. On some gregarine parasites from some polychætes from the Andaman Islands.

B. L. BHATIA and S. B. SETNA, Bombay.

One of the authors of this paper (S.B.S.) during a stay of five months in the Andaman Islands examined the gregarine parasites from four polychætes and made a large series of permanent preparations. The hosts are being identified by the Indian Museum authorities.

Host A.—Contains in its intestine *Lecudina* sp. very similar to *Lecudina aphroditæ* (Lank.).

Host B.—Harbours in its intestine four or possibly five distinct parasites.

(1) *Ulivina* sp., similar to, if not identical with *Ulivina rhynchoboli* (Crawley).

(2) *Stomatophora* sp.—The organism suggests comparison with *Stomatophora simplex* Bhatia, but the sucker has no central mucron.

(3) Septate gregarine. Certain characters re-call the more complete segmentation in *Metamera* and *Tæmiocystis*.

(4) *Contortiocorpa prashadi*, n.g., n.sp.

Host C.—Harbours in its coelome *Nematocystis* sp.

16. A note on the origin of the tonofibrillæ in insects as exemplified by a Cecidomyid (Diptera).

P. SEN, Calcutta.

The muscle fibres in this insect at their attachments with the body wall become highly fibrillated. These fibrillations are continued in a converging manner towards the inner border of the dermis. Difference of opinion exists as to the origin of these fibrillæ. Some hold that these are chitinous in structure and originate from the cuticle. Others including Tillyard and Keilin regard them as hypodermal in origin. The present author recently observed that these fibrillæ in the Cecidomyid larvæ are formed by the special secretory activities of the nucleated hypodermal cells at the base. This observation thus supports the views held by the latter school of observers.

17. The Cuckoo-Shrikes of Calcutta.

S. C. LAW, Calcutta.

Three distinct species referable to two genera are noted from environs of Calcutta and contiguous districts. Distribution, status, and movements discussed. Available records meagre or insufficient.

Lalage m. melaschista Hodgs.—A winter visitor. Time of arrival and departure. Data available from author's own records. Habits and habitat with reference to migratory area in Lower Bengal described.

Lalage sykesii Strickl.—Occurrence in Bengal. Confusion as regards status in its range around Calcutta. Mr. Hugh Whistler's note (The Vernay Survey, *J.B.N.H.S.*, XXXVI, 345) in so far as it mentions this species as 'clearly a rains visitor from about June to September' is erroneous and misleading. Author's observations fairly ample and conclusive, indicating that it is a breeding and resident species. Habitat and nesting area discovered. Young and juvenile coloration described.

Graucalus macei Less.—The form found about Calcutta is according to Whistler *Graucalus javensis macei*. Extremely meagre record of its occurrence. Its status discussed and haunts described.

18. A note on the juvenile coloration of some Himalayan birds.

S. C. LAW, Calcutta.

Four species of the Family *Timaliidae* are dealt with, viz. *Stachyridopsis r. ruficeps* (Blyth), *Pseudominla c. castaneiceps* (Hodgs.), *Fulvetta v. vinipectus* (Hodgs.), and *Ixulus f. flavicollis* (Hodgs.). All collected from Darjeeling and Sikkim. No published record of their juvenile coloration.

19. Observations on the movements of *Dendronanthus indicus* (Gmel.) in the vicinity of Calcutta.

S. C. LAW, Calcutta.

The author's observations regarding this species tend to show that its movements become so pronounced in April and September as to be almost comparable to the migratory movements of some Flycatchers which visit Lower Bengal. Mentioned as winter migrant in both editions of the *Fauna*. Blyth's record 'at all seasons' in the vicinity of Calcutta. Doubt still exists as to its status. No breeding area near Calcutta yet discovered.

20. A note on the variations in the gastric armature of some South Indian Decapod Crustaceans.

A. RAMAKRISHNA REDDY, Annamalaiagar.

The gastric armature in six common South Indian Decapods is described. The general plan of the mechanism is the same in all of them; but the structural details especially of the cardiac and urocardiac cuticularizations, the nature of the denticles and the distribution of setæ vary considerably. The variations are apparently correlated with the nature of the food.

The gastric musculature is also varied in correlation with the development and disposition of pylorics and zygocardiacs.

The gastric armature of *Penæus* is peculiar in that six sharp denticles occur dorsally in the œsophagus which may serve for preliminary reduction of food, before it is subjected to the process of straining and mastication.

The gastric armatures present a well graded series of complexities. *Cerataspis montrosus* described by Bonier presents the most primitive type. The gastric armature of *Penæus* is intermediate between this primitive and more advanced types. *Nephrops* and *Astacus* come next in the series followed by Hermit-crabs, *Albunea*, Field-crab and *Gelasimus* in the order of complexity in the gastric armature.

21. On the origin and development of the pharyngeal gland-cells of earthworms.

K. N. BAHL, Lucknow.

In 1917, Stephenson described the microscopic structure of the dorsal pharyngeal thickening in 3 species of *Pheretima* and also in *Helodrilus*. He denied the glandular nature of the pharyngeal bulb and held that the so-called gland-cells are to be looked upon as of peritoneal origin. In 1920, Keilin demonstrated that the pharyngeal dorsal bulb was a true salivary gland. The present paper deals with the origin and development of the gland-cells based on a study of the early embryos of *Pheretima*, *Lampito* (*Megascolex*), and *Eutyphæus*.

22. A note on the anatomy of *Rachisellus prætermisus* Blanford.

R. V. SESHAIYA, Annamalainagar.

The study of the anatomy of *Rachisellus prætermisus* has shown that the radula and reproductive system are strikingly different from that of *Rachisellus punctatus* Anton. The differences are more marked than what may be expected between species of the same genus. In the radula of *Rachisellus prætermisus* the central is large and rounded and the laterals are arranged in oblique series. These are features characteristic not of the genus *Rachisellus*, but of *Rachistia*, a genus recorded till now from South Africa. What has been known as *Rachisellus prætermisus* appears to belong to the genus *Rachistia*.

23. Anatomy of *Melania* (Radina) *crenulata* (Desh.) var. *tirouri*.

R. V. SESHAIYA, Annamalainagar.

The paper is a study in the comparative anatomy of the Indian Melaniidae. *Melania crenulata*, var. *confusa* (Dohrn), *Melanoides scabra* (Müller), *Acrostoma baccata*, *Acrostoma reeri*, *Paludomus regulata*, *Paludomus blanfordiana*, *Stomatodon stomatodon* have been examined. The anatomy of *Melania crenulata* is discussed in detail. The reproductive system in *Melania* and *Melanoides* shows interesting features. In the male the lower part of the genital duct is in the form of a wide, partially open furrow. In the female a brood pouch is developed under the mantle floor. The oviduct is a slender duct with a conspicuous receptaculum seminis which opens by a slit-like aperture in close proximity to the opening into the brood pouch. The oviduct joins the receptaculum at its lower end. There is also a very slender duct connecting the upper part of the receptaculum seminis and the oviduct which may be considered as a vestige indicating the origin of the receptaculum seminis from the oviduct. The ova are fertilized in the receptaculum seminis and then pass into the brood pouch where development takes place.

24. Study of biological and ecological conditions of estuarine waters of Bengal and their relation to the malaria problem of the province.

G. C. CHATTERJEE, H. K. MOOKERJEE, and A. N. MITRA,
Calcutta.

Fish are recognized as larvivoracious. Estuarine waters contain numerous varieties of larvivoracious fish. Certain conditions increase their number, other conditions diminish them. These fish live upon various types of crustaceans as well as of protozoa; while in their turn they are eaten up by carnivorous fish as well as by beetles and other organisms present in water.

The study of these ecological conditions offers a great field of study to Biologists and Malariologists. This is the first of the series of observations on this subject.

25. Reproductive system and mating habit of Bruchid beetles.

DURGA D. MUKERJI and M. A. HAKIM BHUYA, Calcutta.

In continuation of previous communications the authors have given in this paper the details of the histology of the genital system of the male and female of *B. quadrimaculatus* and *P. chinensis*. A comparison of the structure of the two species is made. The methods of copulation have been studied in detail and the function of bursa copulatrix is discussed.

26. Comparative study of the digestive system of common ants of Calcutta.

DURGA D. MUKERJI and S. R. MAZUMDAR,
Calcutta.

The alimentary canal of the species commonly found in Calcutta, representing sub-families—Ponerinae, Myrmecinae, and Camponotinae—is investigated. A comparison is made between gizzard of the nearly related species of the genus *Camponotus* which contains species with a highly variable structure. Attempt is also made to find out correlation between feeding habits and the structure of the gut.

27. On the morphology of *Chilomitus caviæ*, a flagellate from the coecum of guinea-pig.

H. N. RAY and A. N. MITRA, Calcutta.

Morphology of this flagellate has been described in detail. Presence of an internal axoneme arising from one of the basal granules has been definitely established. Its method of division has also been studied in some detail. Similar flagellates from rats and toads are also reported.

28. On the species of *Stenophora*—a septate gregarine, from an Indian millepede, *Cambalopsis* sp.

H. N. RAY and M. CHAKRAVORTI, Calcutta.

Morphology and life-history of this gregarine are described in detail. A discussion follows on its intracellular habit and method of movement. A method for obtaining cysts of gregarines from millipedes is also given.

29. On a species of *Eimeria* (Sporozoa-coccidia) from the gall-bladder of a lizard, *Hemidactylus coctæi*.

H. N. RAY and M. DAS GUPTA, Calcutta.

This coccidian has been shown to be entirely confined to the epithelium of the gall-bladder of Lizard and that none of the stages in its life-history is passed through the liver or intestine of the host as has been pointed out by another worker. Intestinal epithelium, no doubt, contains a species of *Eimeria*, but it has been found to be quite different from the one in question. Life-history of this *Eimeria* has been described in detail. Unlike *E. perforans* mature oöcysts are found in the faecal matter.

30. On a new species of *Eimeria* (Sporozoa-coccidia) from the intestine of toad, *Bufo melanostictus*.

H. N. RAY, Calcutta.

Morphological peculiarities such as occurrence of a pair of hyaline blades at the anterior end of merozoites, young trophozoites and schizonts and situation of the fertilization spindle at right-angles to the long axis of the macrogametes have been discussed. Two types of schizogony have been described, microschizogony which ultimately gives rise to microgametes, and macroschizogony which gives rise to macrogametes. Schizogony has been found to commence at a very early stage—even before a merozoite has become intracellular. Sporogony is rigidly intracellular.

31. Cause leading to the formation of different forms of vertebræ.

H. K. MOOKERJEE, Calcutta.

In vertebrata we generally find four forms of vertebræ, namely procœlous, opisthocœlous, amphicœlous and heterocœlous. The intervertebral portions of the perichordal tube remain membranous or procartilaginous for a long time. Through these intervertebral zones of perichordal tube, the migratory connective tissue cells enter. The mode of entrance of the migratory connective tissue cells depends on the habit of the embryo. When the embryo oscillates its body except the head, we get the procœlous type. Oscillation towards the opposite direction produces the opisthocœlous type. When the embryo does not flex its body we get the amphicœlous form. Heterocœlous type is the modified form of procœlous.

32. Position of the cartilaginous neural arch in the thoracic vertebra of chelonia.

H. K. MOOKERJEE and A. K. MUKHERJEE,
Calcutta.

Previous workers were of opinion that the position of the basidorsals were at the intervertebral region of the thoracic vertebræ, but our recent investigation disproves their observations. They are really at the vertebral region and between the two consecutive cartilaginous arches there is a connective tissue arch to fill up the gap.

33. On the development of the vertebral column of snake.

H. K. MOOKERJEE and B. K. CHATTERJEE, Calcutta.

The authors have traced the development of the vertebral column of snake. They differ from the previous workers on the constant parts of the upper arch throughout the whole vertebral column and the lower arches at the tail region.

34. Genitourinary system of *Sciurus* (squirrel).

M. A. H. SIDDIQI, Lucknow.

The anatomy of the system is described. A detailed account of the neck of the bladder, prostate gland, ductus deferens, and prostatic urethra is given. Special attention has been drawn to the mucous membrane of prostatic urethra which shows two semi-lunar folds, two pairs of culdesacs, and the median verumontanum.

The course and relation of ductus deferens and the ducts of prostate glands has been investigated by means of serial sections of the part. The sections have been traced by a drawing projection apparatus and a magnified reconstruction of the part has been made from which the following observations are recorded :—

The prostate gland is tetra-lobular and situated entirely outside the wall of prostatic urethra.

The prostatic secretion is conveyed by 4 ducts which enter through the muscularis of the prostatic urethra and raise a semi-lunar fold of mucous membrane across the posterior part of urethral cavity and which can be rightly called the 'Genital Fold' as it conveys the ductus deferens also.

The three pairs of ducts, i.e. ductus deferens and prostate ducts open independently about the same level on the surface of verumontanum near the middle of prostatic urethra.

Prostatic sinus has no ductular opening.

The seminal vesicle and consequential formation of ejaculatory ducts are absent.

Uterus masculinous is absent.

Neck of bladder protrudes into the posterior part of the urethra and forms a semi-lunar fold which may be rightly called the 'vesical fold'.

Paper was illustrated by lantern slides.

35. The course and distribution of the anterior remus of a typical thoracic nerve in man and certain other mammals.

M. A. H. SIDDIQI and A. N. MULLICK, Lucknow.

Cunningham stated that the nerve lies between the external and the internal inter-costal muscles and this description appears in most of the text-books on human anatomy. Walmsley in 1916 showed that the nerve does not lie between the above two muscles but in a plane deeper to the internal inter-costal.

Stibbe, David, and Gladston in 1932 described four musculo-fascial planes in each inter-costal space and that in each space the main nerve lies with a collateral nerve deep to the internal inter-costal. They deny the existence of any nerve between the external and internal inter-costal muscles.

The investigation is based on the dissection of inter-costal spaces of 60 human thoraxes of different ages and a comparative study of the same on dog, cat, rabbit, monkey, goat, and lamb.

The conclusions arrived at are the following :—

(A) Human—

There are five muscles in each inter-costal space, arranged in three-planes :—

(a) External inter-costal.

(b) Internal inter-costal.

(c) Sub-costal, intra-costal, and transversus thoracic, connected to each other by the endothoracic fascia.

The main nerve lies between the internal inter-costal and the innermost musculo-fascial plane.

A big collateral nerve is given out in some spaces only and occupies the same plane as the main nerve.

A long branch of the main nerve is present between the external and internal inter-costal muscles and supplies these muscles.

(B) Other animals examined—

Arrangement of musculo-fascial planes and the main nerve is in general identical to human being.

Collateral nerve is absent in every case.

A long muscular branch between the external and internal inter-costal muscle is present in every case.

Paper was illustrated with lantern slides.

36. A case of human ischiopagus double monster.

M. A. H. SIDDIQI, Lucknow.

The digestive and genito-urinary system of a human ischiopagus double monster fetus has been described and the points of special interest summarized below have been discussed and explained embryologically.

A common anterior abdominal wall, navel, genital tubercle, and peritoneal cavity are present.

There is a single common colon into which small intestines of both fetuses are continuous.

The anal canal is absent, the distal end of common colon opens by an orifice into a common bladder cavity.

The common urinary bladder presents a transverse ridge, showing its double origin.

There are two urethral canals, tracking towards the common genital tubercle.

The ductus deferens terminates on the bladder wall. Its continuity with the urethral canals is not traceable.

Paper was illustrated with lantern slides.

37. Arrangement of superficial veins of cubital fossa in Indians.

M. A. H. SIDDIQI, Lucknow.

The investigation has been carried on 400 human beings of both sexes. A blood pressure instrument tourniquette was applied to the upper part of arm and the prominent obstructed veins were marked by a skin pencil and later charted out on cyclostyled cubital fossa sketch sheets. Various types of arrangements are classified. A comparison has been made with various arrangements as found in other nationalities and reported by Kiknokamoto (Tokyo) in Japanese, Berry and Newton, in Australian born British, C. M. Charles, in American Negro males and American white males.

Paper was illustrated by lantern slides.

38. The developmental stages of *Palæmon lamarrei* H.M.-Edw.

K. N. DAS, Calcutta.

Very little is known about the life-history and developmental stages of Indian freshwater prawns and shrimps. Early stages from the egg onwards of *Palæmon lamarrei* H.M.-Edw., a common freshwater shrimp of Bengal, were reared in the laboratory. In this paper descriptions are given of a number of stages within the egg case and of free stages till the adult characters of the prawn are developed.

39. Structural modifications of the pelvic fins and basipterygia of the torrential fishes, with special reference to the function of adhesion.

DEV D. MUKERJI, Calcutta.

Fishes and other animals that inhabit torrential streams have undergone remarkable structural modifications which can be directly correlated with their life in swift currents. Of the diverse structural peculiarities exhibited by the torrential fauna, there are none so interesting and instructive as those that are associated with attachment and progression on smooth rocks and stones in torrents. Certain torrent-inhabiting fishes have developed vacuum suckers, striated pads of skin on the chest region, broad and papillated or striated lips, etc., for adhesion; but in all cases the paired fins, specially the pelvics, which are extensive and horizontal in position, are the most important agency for attachment.

The present paper deals with a comparative study of the modifications of the pelvic fins, the basipterygia and the associated structures of certain highly specialized torrential fishes of India and other countries. It is shown that adaptation to environment is no more than a series of functional adjustments of the organisms to varying external conditions of their existence. Under the stress of the environment structures become modified in a variety of ways to serve new functions and thereby to bring about a close adjustment between the organisms and their changing habitats. It is further indicated that structural modifications of the pelvic fins and their associated structures, like other adaptive structures, are, almost in all cases, of distinct utility to the species concerned.

40. A study of the otoliths of *Psettodes erumei* (Bl. Schn.).

S. RANGA RAO, Madras.

The otoliths of a hundred specimens varying in size from 8.0 cms. to 40.0 cms. were examined with a view to find out how far they are useful as indicators of age.

The zones of growth are seen. The boundary lines between successive zones are distinct and definite in many cases. A complete zone is considered to be the result of a year's growth. The otoliths of most specimens collected during August and September show distinct beginnings of the formation of an opaque ring at the outer edge which seems to be due to better conditions of growth. This opaque ring marks off the previous year's growth.

Observations on the stomach contents and the gonadal condition point out that the period from August to September is more favourable for growth. The breeding season probably commences from about October.

The lengths of the specimens are correlated with the respective lengths of the otoliths and the co-efficient of correlation is found to be 0.95.

An attempt is made to sort out the specimens into age-groups according to the number of zones present on the otoliths. The average growth of the several age-groups is shown.

41. The anatomy of the adhesive apparatus in the tadpoles of *Rana afghana* Günther, with special reference to the adaptive modifications.

J. L. BHADURI, Calcutta.

Ranid tadpoles show a great diversity of form and structure which can be correlated with life in different types of habitats. The tadpoles of *Rana afghana* live in torrential streams and show certain adaptive specialization in their structures enabling them to adhere to rocks and stones in swift currents.

Broadly speaking the process of adhesion in *R. afghana* tadpoles is carried on by two distinct structures: the cement organs and the suction disc. The cement organs act as a powerful adhesive structure in the nascent larval stages, while the suction disc acts throughout the life of the tadpole. The lips of the tadpole which are provided with several rows of backwardly directed teeth also act as powerful organs of attachment.

A histological description is given of the cement organs and attention has been directed to the 'brush-border' fringing the gland cells of the cement organs.

Anatomy of the muscles of the disc is fully described. The homologies and the functions of the muscles are discussed. A histological account of the skin area of the disc is also appended. An attempt has been made to show a definite correlation between the modified structures of the adhesive organs and the habits and habitats of the tadpoles.

42. On a new trematode from kingfisher.

G. S. THAPAR and M. B. LAL, Lucknow.

Several specimens of the form described in the present communication were obtained from the intestine of a kingfisher shot at Lucknow; they belong to the family Psilostomidae and present the following characters:—

Absence of the body spines; Y-shaped excretory bladder; ovary in front of the two testes, situated in the middle of the body behind the ventral sucker; vitellaria not meeting in the middle at the posterior end of the body; relatively long uterus with large number of eggs; dextral

position of the genital pore; vesicula seminalis situated in front of the ventral sucker; cirrus short and plumpy.

These characters are such that they are not present collectively in any of the hitherto described forms of the family, though certain characters are present in different forms.

A detailed account of the anatomy of the worm is given and is followed by a discussion on its systematic position.

43. Burrows of *Thalassema bombayensis*.

P. R. AWATI and D. S. DESHPANDE, Bombay.

The burrows usually have a more or less permanent aspect and may be approached by two entrances. At low water broad areas are left bare, but *Thalassema* drills its home in such a place that the entrance is not uncovered by the lowest tide. The burrowing is performed by the combined action of the proboscis, the swollen anterior region of the body with its ventral setæ and the waves of the muscular contractions which pass along the body from behind forward. The proboscis is protruded, and passed into the sand and withdrawn full of sand and again everted. The body is thrust forward partly by the action of the longitudinal muscles of the body wall, and partly by the peristaltic waves produced by the circular muscle by means of which the anterior end is rendered swollen and tense, and is thus enabled to enlarge the burrow. Also the ventral setæ take part in scraping of the unnecessary corners. By these means a passage is cut through the sand and smoothed by contact with the skin, and may be lined with mucus secreted by the epidermis. After burrowing vertically downwards to a depth of from 1 to 2 feet it makes a horizontal or oblique gallery, and then a second vertical one, which opens on the surface of the sand in a funnel shaped aperture. The burrow is never carried deep, has two entrances and is perpendicular and the bottom horizontal. Even in the institute aquaria these animals prepare their burrows in the form of expanded U which can safely be said to be their natural instinct. The apertures of ventilating doors are small, being about one-third the diameter of the tunnel itself. Around one of the openings there is a considerable amount of castings. The greatest distance between their natural burrows measured 45 inches, the shortest 16 inches. Twenty-six was the average for many measurements. The distance between the two entrances depends upon the size of the animals but this is not always the case, for at times even a small specimen may have more extensive burrows for their size than larger ones. The largest specimen obtained was 20.5 inches long when relaxed in anæsthesia and the smallest one an inch.

44. Food getting in *Thalassema bombayensis*.

P. R. AWATI and D. S. DESHPANDE, Bombay.

The method employed by *Thalassema* to gather nourishment is no doubt unique in nature and furnishes a striking example of the adaptive nature. The ventral cilia of the proboscis and the flask shaped mucus glands of the same play here the most active part. These mucoid glands secrete a thin film over the surface of the water which interposes small organisms, and when this so-called townet is fully loaded, is driven towards the mouth by the currents produced by these ventral cilia. Here the proboscis also plays a good part in prehension of good material and by definitely seizing the prey and rolling into the mouth.

45. Respiratory movements in *Thalassema bombayensis*.

P. R. AWATI and D. S. DESHPANDE, Bombay.

There are two separate movements which would be considered under two headings: (1) the peristaltic movements along the body wall which

pump fresh water along the body into the tunnel, and move that within the respiratory chamber of the body; (2) the inhalations and exhalations through the anus for which there is the muscular chamber resembling that of a Holothurian, which is the power house which supplies the chief motive power.

The peristaltic movements of the body serve to propel fresh water in the burrow. The wave which expands the body to fill the burrow, begins at the anterior end and pass along the body posteriorly. As the wave arises at the posterior end a fresh one begins at the anterior end and this is continued for some time. Afterwards there is a short pause and now the wave begins from the posterior end. This cycle is repeated off and on. The *Thalassema* is always in control of the water and senses anything which may attempt to pass through the burrow.

The inhalations are from one to upwards of 20 in succession before exhalation takes place. The exhalations are usually a single discharge. The rate of breathing is not uniform. At times four inspirations covering 25 seconds were followed by an expiration period of 10 seconds, while in another instance 10 inspirations occupied 30 seconds the expirations only five; twenty inspirations occupied six seconds, the single expiration forty seconds; thirty inspirations occupied forty-five seconds the expirations only twenty. These timings were taken on a specimen in the laboratory aquaria.

46. On developmental Cranioschisis in the embryo of dog.

D. S. DESHPANDE, Bombay.

Malformations and anomalies affecting mammals and lower animals are not uncommon. The following is an interesting case of cranioschisis on the embryo of dog. The crown rumps length of the embryo is 10 mm. In all respects the embryo was normally developed except for the extensive acrania. The entire roof of the skull is lacking and the brain and its membranes are reduced to small uneven masses of tissue lying upon the floor of the skull. The brain showed a flattened and grooved structure widely open up to the first cervical vertebrae. The masses of the brain tissue appeared raised above the level of the defective skull like a turban unevenly tied.

Normally the neural tube is formed from the neuroderm extending along the dorsum of the embryonic disk. The neuroderm layer gets thickened, a groove appears along the middle line, and the margins are raised above the surface of the embryo, forming the neural groove. The margins of the band grow upward and finally fuse with each other throughout their entire length in the middorsal line. The surface ectoderm then separates from the line of fusion and forms a continuous layer upon the dorsum of the embryo thus leaving the neural tube extending the entire length of the embryo immediately beneath the ectoderm.

The formation of the neural tube is the fundamental process and occurs in the embryo at an early period. It is obvious that any interference with its development will be followed by serious defects in the nervous system and the structures that immediately surround it. A most natural result of such interference would be the failure of two margins of the neural groove to unite and it is not improbable that the form described above is the result of imperfect or complete lack of closure of the cephalic end of the neural groove.

47. A report on a bull-frog (*Rana tigrina*) devouring a sparrow.

D. S. DESHPANDE, Bombay.

While dissecting a full-grown bull-frog (*Rana tigrina*), measuring 6 inches in length and 2.5 inches in breadth, obtained from the College tank,

it was seen that the region of the stomach was very tense and abnormally swollen. On opening I was surprised to find a nearly full-grown sparrow inside its stomach. The sparrow measured 3 inches in length and 1.5 inches in breadth. The bird had undergone partial digestion at many places.

The frog in all other respects was quite normal save for an unusual bulging of the abdominal region. The stomach measuring 2 inches in length and 1.5 inches across the diameter, was very distensible.

It may, at first sight, seem impossible that the frog had attacked the sparrow while it was alive. It is however possible that the sparrow while in search of its prey must have fallen in the water. No doubt, the frogs in the tank must have suffered long starvation and hence all had made a bold step in attacking the prey. The largest and strongest must have been successful in his attempt to swallow the bird though it had to undergo great discomfort.

48. A new species of thrips from S. India (*Tæniothrips cardamomi*, sp. nov.).

T. V. RAMAKRISHNA AYYAR, Coimbatore.

During a recent study of some insects and other pests of the cardamom plant in two or three tracts in South India, a species of 'thrips' was noted causing appreciable damage to the cardamom capsules in an estate on the Anamalai hills in South India. On a special study and comparison of this insect with the allied forms of the group in the Thysanoptera, it was found to be a species not named or recorded so far. It is, therefore, described in this paper, especially because it has some economic importance and agricultural entomologists would like to get the insect properly named for future reference. It is named after its food plant—*Tæniothrips cardamomi*, n.sp.

49. On the morphology of a new trematode of the genus *Haplorchis* from the intestine of *Pseudentropius taakree*.

J. DAYAL, Lucknow.

A large number of trematodes were collected from the intestine of *Pseudentropius taakree*.

Only two species *H. cahirinus* and *H. pumilio* of the genus *Haplorchis* (Looss, 1899) have been described. Of these, Witenberg (1930) considers *H. pumilio* to be identical with *Monorchotrema taihoku*.

The present species resembles *H. cahirinus*, and is interesting as it will be a second species of Heterophyidae found in the adult stage in the intestine of a fish (if Witenberg is correct), *H. cahirinus* being the first. The new form presents many differences from *H. cahirinus*, chiefly in the size of the intestinal caeca, in the relative size and position of the genital organs and the size and position of the receptaculum seminis. All these differences along with other minor differences indicate that the form is a new species.

The paper concludes with a short discussion on the classification of the sub-family Haplorchinae (Looss, 1899).

50. A note on a Pangolin, *Manis crassicaudata* found in H.E.H. the Nizam's Dominions.

M. RAHIMULLAH, MOHD. A. R. KHAN, and B. K. DAS,
Hyderabad (Deccan).

Two species of Indian Pangolins, viz. *M. crassicaudata* and *M. pentadactyla* are known to be distributed in various parts of India; the

former with 11 to 13 longitudinal rows of scales over the body occurs practically throughout the Peninsula, whereas the latter with 15 to 19 rows of scales is limited to Himalayas, Sikkim, Assam, and Burma. The specimen under investigation was approximately a full-grown ♀ *M. crassicaudata* found at an altitude of about 1,450 ft., and measuring 39.5 cms. (including the head=7.5 cms.) in length, and the tail is 30 cms., and the greatest girth of the body is 41.2 cms.

The body is covered with scales (average size: 6 cms. \times 4.9 cms.) arranged in an imbricate manner, the undersurface being quite free, whereas the tail (bluntly pointed) is covered all round with scales. The scales on the head (which are absent on the ventral surface) present a beautiful diamond-shaped appearance and become gradually reduced to a very small size towards the snout. Scales are, however, absent from the preaxial sides of both the fore- and the hind-limbs. Immediately over the region of the thigh-joint, there is a patch of skin which is scaleless, whereas in the case of the fore-limb there is no such gap. Soft bristles are sparsely distributed over the back, the legs, and the tail.

The digits are provided with claws which are very strongly developed on the fore-feet in correlation with the digging habit, and amongst these the 3rd claw being the largest—the one on the fore-foot is nearly 3 times the size of that on the hind-foot.

As regards colouration it is light brown all over, the undersurface being much paler; and the ventral surface of the head being brownish grey, whilst the snout is light grey.

The walls of the stomach have few folds and are fairly smooth in character, whereas the pylorus is nearly twenty times as thick, and its mucous membrane is considerably hardened and rough in appearance.

Numerous nematode parasites have been found in the rectum, which have been studied.

51. On the pyloric cæca in the family *Notopteridæ*.

M. RAHMULLAH, Hyderabad (Deccan).

At the last Science Congress, with a view to make a systematic survey of the pyloric cæca amongst the fishes found in India the author, to start with, had described the condition of the cæca as found in the Family Ophiocephalidæ, and this year he proposes to discuss the structure of the cæca in the family Notopteridæ.

In *Notopterus notopterus*, Pallas, lying immediately below the large gas-bladder is the intestine which is short and simple and is disposed in a semi-circular loop; and below the latter (and almost hidden between it and the globular stomach) are the two cæca, viz., the dorsal (larger) and the ventral (smaller) cæca, which are very closely situated together and run parallel to the intestine, the pylorus being very small.

In a fish measuring 24.4 cms. in length the ratios of the lengths of the dorsal and the ventral cæca (each taken as a unit) to those of the intestine and the whole of the alimentary tract are nearly 1 : 2.5 and 1 : 4; and 1 : 3 and 1 : 5 respectively. Both the gastric and the intestinal branches of the coeliac artery supply them with oxygenated blood, whilst the venous blood from these structures is drained by the intestinal factor of the Hepatic Portal vein. The left visceral branch of the vagus innervates the stomach as also both the cæca, whereas its right counterpart supplies the stomach, the intestine, and the dorsal cæcum.

Complete histological details of these two cæca have been studied and compared with those of the Ophiocephalidæ. They belong to the simplest type found in *O. gachua*, and present more or less feather-like appearance in section. Curiously enough, the mucosa of both the intestine and the cæca possesses finely ciliated epithelia.

52. Report on some poisonous snakes found in Hyderabad (Deccan).

B. K. DAS, Hyderabad (Deccan).

Four distinct species of poisonous snakes (as also found in certain other parts of India) have come under the notice of the author. The cobra (the 'Gokhura' or 'Nag sâmp'—the spectacled or the biocellate type), *Naia naia* is quite common: the monocellate variety (i.e. the 'Keutiah') seems to be absent. Nearly all the cobras found here are either brown or olive-brown in colour, having a distinct spectacle mark on the hood, and only a few are blackish. Next comes the Russell's viper (the 'Daboia' or 'Chandrabora'), *Vipera russelli*, locally called 'Pinjara' (and its younger forms known as 'Chirgoo' and supposed to be the most venomous snake of this place), which is equally common, and is usually met with amongst low bushes and very often in areas thickly covered over with *Cactus*. Majority of deaths are due to the bite of this viper. The common 'Krait' ('Dhomm Chitti' of N. India), *Bungarus caeruleus* is not so common as the other species, whereas the banded 'Krait' or 'Raj sâmp', *Bungarus fasciatus* is the least common species, having dark cross bands over a light brown background.

Various other details have also been discussed.

53. Partial hermaphroditism in *Rana tigrina*.

SHADI LALL, Lahore.

In an adult functionally male specimen of *Rana tigrina*, caught from a dirty *nala* across Lahore railway lines near Landa Bazar, the author chanced to discover on 22nd May, 1934, during demonstration work certain abnormalities in its reproductive system. The animal gave no definite clue of the sex from outside. On dissection it showed a pair of unequal testes, the right one being about half the size of the left. A pair of complete well-developed oviducts were also present. Both the uteri and the urino-genital ducts were seen to run in close contact opening separately in the cloacal chamber. No trace of the ovary, however, was discovered.

So far two nearly identical cases of hermaphroditism have been recorded in *R. tigrina* in India; one by Bhattacharya and another by Bhaduri. This is a third instance of its kind recorded, for the first time, from the Punjab.

54. A study of two species of *Typhlops* found in Lahore.

HAFEEZ ULLAH, Lahore.

The paper contains an account of two species of *Typhlops* occurring in Lahore, one of which is *T. braminus* and the other appears to be new to science.

Some interesting points with regard to the anatomy, morphology, and habits of the two species are dealt with in the paper.

55. Preliminary observations on the morphology and bionomics of the House-shrew (*Crocidura cerulea*).

K. L. MALHOTRA, Lahore.

The author has been engaged in a study of the House-shrew since June, 1934. Specimens of this species have been collected from Lahore and its suburbs, and other localities in the Punjab, such as Muridke and Haranpur.

According to Dobson *Crocidura caerulea* is a semi-domesticated form of *Crocidura murina*. This view is not corroborated by the author's observations.

Attention is directed in this paper to certain features of interest in regard to the skeleton.

56. The development of the male genitalia of the house-fly (*Musca nebulosa*).

NASEER-UD-DIN, Lahore.

In the adult house-fly the male genitalia consist of a median copulatory organ. The aedeagus, two pairs of lateral processes, the parameres, and the coxites with their styli and the anal cerci. All of these structures are borne by the 9th or the last abdominal segment.

There is one more pair of accessory forceps situated on the sternite of the 5th abdominal segment.

After the larva has pupated there are found two solid lobes hanging down from the roof of the genital cavity, these are the paramere lobes.

At the next stage of development these paramere lobes divide by a longitudinal fissure into two pairs: an inner and an outer. The two inner lobes fuse along their median lines and form the aedeagus, and the outer pair form the parameres. There arises a pair of appendages from the 9th sternum, each one of the appendages is situated to the exterior of the parameres. These appendages are the coxites. The apical portion of these coxites, during development, are constricted off as their styli.

There arises two appendages from the tergum of the 9th abdominal segment, one on either side of the rectum. These appendages bend down and meet in the mid-ventral line below the rectum. These appendages are the anal cerci. The accessory forceps make their appearance as two hollow outpushings from the posterior side of the sternite of the 5th abdominal segment.

57. A preliminary study of the soil Protozoa of Lahore.

AHMAD HUSAIN, Lahore.

92 samples of soil were examined for Protozoa. The following media were used: Hay Infusion, Ashby's Mannite medium, horse dung medium, Shornton's medium, soil as medium and nutrient medium. The paper contains an account of the species found in the samples of soil.

To estimate the presence of Rhizopod tests two methods were tried: (a) Sandon's method of inoculation of soils in tap water and examining at intervals; (b) Winogradsky's centrifuging method. The testaceous rhizopods are commonly met with in peaty soil or acid soil and are hence scarcely found in the Punjab where the soil is usually alkaline.

58. Role of the Golgi apparatus in the formation of the acrosome in the male germ cells of the Lahore centipede *Rhysida longipes*.

G. R. GADHOKE, Lahore.

Broadly speaking, there are two views regarding acrosome formation. According to one, the acrosome is a secretory product of the Golgi apparatus; while, according to the other, the Golgi apparatus is directly transformed into the acrosome. In the present paper the author has made an attempt to ascertain which of these two views is correct.

The Golgi bodies form a Golgi apparatus in the young spermatocyte. The apparatus consists of chromophilic batonets, clumped together and enclosing a nonstaining sphere substance. This breaks up into individual Golgi bodies, each composed of a chromophilic crescent enclosing a portion of the sphere substance.

After meiosis, the spermatid is formed. The Golgi bodies aggregate posterior to the nucleus, and later fuse together forming the acroblast, which is composed of a chromophilic outer shell enclosing a non-staining substance within. The acroblast travels to the anterior end of the nucleus and a perforatorium is formed within the non-staining region. The whole structure now is the acrosome.

The acrosome in the Lahore centipede is formed by a fusion of the Golgi bodies, as in the crab *Paratelphusa* (Nath, V., 1932).

The Golgi material is not sloughed off after secreting the acrosome as advocated by Bowen, Payne, and Pollister.

59. The musculature and nerve supply of the genitalia of the ak-grasshopper (*Pæcilocerus pictus*) and the desert locust (*Schistocerca gregaria*).

S. S. KAPUR, Lahore.

Specimens were preserved in 5% formalin for the study of the neuromusculature of the genitalia. The arrangement and number of muscles were found to be identical in both *Pæcilocerus pictus* and *Schistocerca gregaria*.

This paper contains an account of the boring habits and the part played by certain genital sclerites in egg-laying as well as the action of certain muscles of the genital segments in respiration.

Nerve supply to the genital muscles has also been investigated.

60. Some entomostraca from Karachi.

G. L. ARORA, Lahore.

The author made a collection of marine Entomostraca from Karachi both inside and outside the harbour in December, 1933, and January, 1934. The list of Entomostraca given in the present paper is yet incomplete. The order Copepoda is represented by nine genera, viz., *Calanus*, *Eucalanus*, *Paracalanus*, *Acrocalanus*, *Candacia*, *Temora*, *Centropages*, *Pontella* and *Acartia* while the genus *Evadne* is the only representative of the Cladocera.

A statistical statement of these genera is also given in the paper.

61. Incidence of Helminthic parasites in cattle in Lahore.

SUKH DYAL, Lahore.

During October, 1933, and April to May, 1934, the author used to visit the Beef Slaughter House, Lahore, in order to determine the incidence of Helminthic parasites in cattle. In the course of 40 days he examined 1,043 animals, of which 1% were infected with *Fasciola*, 2% with Cestodes, 14% with Paramphistomi, 20% with Bladder worms, and 8% with *Filaria*, i.e. in all 458 animals or 45% were infected. *Filaria* (all *Bos indicus*) seems to be harmless to its hosts.

Section of Anthropology.

President :—DR. G. S. GHURYE, M.A., Ph.D. (Cantab.).

Presidential Address.

ANTHROPOLOGY AND OUR EDUCATIONAL SYSTEM.

The subject of Anthropology is still new and strange enough to evoke different reactions in the minds of different people. To the layman it conjures up pictures of skulls and other bones, sometimes of the 'weird' customs of 'savage' peoples and 'curious' implements made of stones and bones. The growth of this branch of knowledge is chiefly responsible for this state of affairs. Discussion of the place that man occupies in the animal world, the shape of his skull and the various criteria of differentiating between the skulls of the various peoples has long been prominent amongst many notable students of medicine and anatomy. And it attracted very keen notice of a number of laymen because the conclusions that such inquiries led to were opposed to some of the doctrines held by the Christian Church. Discussions of the problems mentioned above were generally styled Anthropology among the serious students. In the popular mind Anthropology has therefore been intimately associated with the skulls and bones of man. It was not until the 19th century that Archæology, or 'Prehistoric Anthropology' as Dr. A. C. Haddon calls it, attracted serious attention of the scholarly world. The finds of Archæology making an appeal to the student and the layman are again skulls, bones, and implements of stones, bones and even metal. The popular impression about Anthropology was thus further fortified by the pursuits of archæologists. A little later information about the life of 'savage' people began to be collected which was avidly read and digested by some of the most brilliant minds of the middle of the 19th century. And their books based largely on such information appealed to a very large section of the educated public owing to the charm of their style. Thus the popular conception of Anthropology was formed.

That Anthropology is concerned with the affairs of 'primitive' or preliterate peoples is an impression which is strengthened by the practice of professed anthropologists themselves. Early students of human culture were interested in tracing the stages through which human institutions, culture, and languages have passed in arriving at their present forms. Preliterate peoples, or at least some amongst them, were considered to be more or

less in the state in which the earliest human ancestors of man must have lived. They were termed 'our contemporary forefathers'. Some of these writers no doubt devoted their attention to a scrutiny of ancient civilizations. Among the second batch of writers, with few exceptions, attention came to be centred more and more on the culture of preliterate people. Travellers and missionary workers described the lives of 'natives' in various books calculated to arouse the interest of white peoples in their mission of civilizing the backward people. All the advantages of focussing public attention that novelties possess were thus with the study of preliterate peoples. It was rightly felt by people, whether they believed in the supposed pristine purity of the 'native' culture or not, that it was very important to make a complete and detailed record of that culture as soon as possible, as otherwise there was every possibility of its being lost once for all for the students of human culture. When Dr. Haddon, the father of British scientific Ethnography, organized his brilliant expedition to Torres Straits, he did it with this realization. Since then most of the professed anthropologists have won their laurels and become known through their work of acutely observing and minutely describing the cultures of many of the preliterate peoples. In the journals devoted to Anthropology most of the space is occupied by articles dealing with some aspect or aspects of one or the other of the many preliterate peoples of the world. Papers dealing with civilized peoples are very rare indeed. And where we do find attention turned to these peoples it is either in connection with their racial affinities or their prehistoric ancestors and their cultures.

Prehistory is rightly described as the description of culture which is neither studied from its possessors while they live nor from any written records left by them but which is partially reconstructed with the help of the artefacts which their fashioners left behind them and supplemented, if possible, by a study of written records. Interest of professed anthropologists in the subject of Prehistory dates from the time of the discovery of remains of human artefacts in some parts of Western Europe. The idea was more or less prevalent that the doings of the prehistoric man of Europe were representative of the earliest stage of human activity and perhaps could be more intelligibly interpreted in the light of our knowledge of the contemporary 'hunters' from among the 'primitive' peoples. The physical remains excited curiosity not only about the primitive ancestors of the modern European races but also held forth promises of explaining the various stages in the evolution of the human skeleton. Thus the knowledge of prehistory of Europe was easily assimilated within the field of Anthropology both in its conception as well as its actual practice amongst the professed anthropologists. But the bounds of our knowledge of the childhood

of man were being extended in many other directions and lands where scholars, who were explorers and historians, were making chance-discoveries or planned explorations not only of human artefacts but also of written records. The writings, which were baffling for some time, began to yield to the patient work of many savants and shed light on the early stages of the cultures of Egypt and Palestine, Asia Minor, Mesopotamia, and Persia. In Egypt and Italy even earlier work of man, which was unaccompanied by writing and was therefore within the province of strict prehistory, was discovered. Added to the prehistoric cultures of Western Europe the work of scholars for two generations has revealed the prehistoric cultures of Central and South-Eastern Europe, of the Caucasus, and of the Caspian, of Central Asia, of China, of India and in particular of the Indus Valley and of Africa. The earlier stages of human cultures in Egypt, Mesopotamia and other lands, which early developed very high civilizations, require for their interpretation a good knowledge of the antic scripts and languages of those lands. Their handling and interpretation has therefore been largely carried on by scholars who are styled 'Ancient Historians' and the results of their work are generally reported in journals which are devoted to the history of the specific countries. Very rarely does it happen that even the significant facts revealed by a detailed study by the specialist savants, find their way into journals which are devoted to Anthropology or Sociology.

Now it is well known to the students of the history of human culture that the early stages of the civilizations of man are to be looked for in these lands rather than in the prehistoric soils of Europe or Africa. The way commerce, invasions and other human activities brought into close contact, one with another, the various cultures in the Caucasus, in Mesopotamia, in Egypt, in the Ægean and even in China is a fascinating and an instructive study in the development of civilizations. It establishes the reality of culture-contact and its effects in furthering the cause of higher civilization. That culture does not run uniformly but has its own cycles is another important lesson which is impressed upon the minds of students of the civilizations of these areas. It leads the thinking mind to probe into the causes of cyclical changes of civilization. Study of the cultures of these areas is bound to tell the students the extent to which every succeeding and higher phase of civilization is reared on the basis of the preceding ones. Altogether it furnishes the best proof of the conscious or unconscious co-operation of the human mind in creating the civilization that Europe, before the development of modern science, became an heir to and thus emphasizes the supreme need for patience, tolerance, and respect for some of the contemporary peoples for their present backwardness. To Indian students it will bring a mental balance which will enable them to avoid a sense of inferiority or of

complacency whose manifestations are very detrimental to our national interests. And yet this important and significant aspect of a study of culture does not find its proper place in the official conception of Anthropology, which deals almost exclusively, in the practice of anthropologists, with the culture of preliterate peoples. Even in the syllabuses of the degree-courses in Anthropology of many of the British Universities such a study is not prescribed. The syllabus of the London University in this subject is perhaps the most comprehensive and conceived in a very liberal spirit. But even in that syllabus the study of culture that is expected of the candidates for the Honours-degree in Anthropology does not extend to the study of most of the great ancient civilizations.

What I have said about the study of culture so far refers to those aspects of culture which are not comprised in social institutions and religious beliefs and ideas. In the matter of religious beliefs and ideas, thanks to the works of Sir J. G. Frazer, the students of Anthropology are always brought face to face with ideas not only of the preliterate peoples but also of peoples of all ancient civilizations, whoever have to contribute to this common heritage of humanity. And the work of Sir G. Elliot Smith takes us one step further by asking us to view the ideas and practices of preliterate peoples in this domain of life as having been in some way derived from the ideas and practices of peoples who created the first civilization. Regarding social institutions, the subject is not equally liberally handled. Though the early anthropological sociologists like Maine, Morgan and others had their eyes on their comparative study with a view to elucidate their more recent and modern forms the practice of later anthropologists has been mainly to confine their attention to their forms and functions among preliterate peoples, leaving a wider and comparative study to the care of sociologists like Westermarck and Hobhouse. This practice of anthropologists is, in some measure, due to the fact that certain types of social institutions, are superficially at least peculiar to the preliterate peoples. I purposely say superficially because I believe that a more detailed study of even these institutions reveals that they have their analogies or substitutes in the institutions of peoples more highly civilized than the 'primitive' peoples. One effect of this dissociation is that a comparative study of social institutions including their modern forms is exceedingly rare among anthropologists, and it is only in Universities, like that of London, where Sociology has been flourishing by the side of Anthropology that the Degree-course in Anthropology prescribes a study of comparative social institutions.

The study of the physical side of man was in its early stages carried on with a view to shed light on his physical evolution, to determine his place in Nature and to ascertain the earlier races

of Europe and their affinities with the present races. Out of this study arose the classification of human races and anthropologists have carried on the work of distinguishing and comparing the various extant races and sub-races of mankind. 'Physical Anthropology' is generally accepted to comprise this study. To the students of the racial problems of mankind as to the students of culture, the problem of mixture of races and of miscegenation presents itself before long. Similarly curiosity about the relation between head-form and race on the one hand and the capacity of the brain and intellectual and temperamental ability on the other is evoked. Proportions between the various parts of the body and their relation to the phenomenon of growth is another enquiry that has presented itself to thinking minds. Students of Biology, Psychology, Sociology, and Anthropology have been variously engaged in investigating and writing on these problems. The subjects of racial psychology and miscegenation having political significance have been handled by all sorts of people, some of whom have succeeded in creating prejudice in the lay minds. Political writers and sociologists have contributed more to the study of these subjects than anthropologists. And 'Physical Anthropology' is still officially conceived as mainly dealing with the physical evolution of the races of mankind. Thus you will have seen that the layman's view about Anthropology is, partially at least, the consequence of the attitude and actual practice of professed anthropologists.

I have troubled you with this short history and development of our subject because I think that in the educational history of our country the present era is potent with powers for great good or evil, and it is exceedingly important to formulate a true conception of the real scope of our subject. Recently there has been a tendency in some of our Universities to introduce in their curricula the subjects of Anthropology and Sociology. At this juncture it is desirable to define our province in a catholic spirit so that there may not be dissociation nor overlapping. Unfortunately there is already prevalent the view which confines Anthropology to preliterate peoples, Sociology to modern nations, and Ancient History to ancient civilized peoples. It is my earnest desire to protest against this view that has led me to address you on this subject. I firmly believe that courses in Anthropology must include one on the comparative study of culture and another on comparative social institutions, embracing the culture and institutions of preliterate, ancient-civilized and modern nations. Similarly, courses in Sociology must include them both, and in addition a course on Race. The distinction between the course in Anthropology and the one in Sociology must lie only in their emphasis. While in Anthropology racial evolution and distribution and the cultures and the social institutions of preliterate peoples are

studied in vastly greater detail, in Sociology this stress must be laid on modern nations. Any other distinction is, I submit, spurious and detrimental to the best interests of both the subjects and of society.

The other point which I wish to dwell upon in this address is the place that the subject of Anthropology, with its scope defined as above, should occupy in the educational system of our country. The reasons why certain subjects are included in the modern educational systems lie largely rooted in the past. They have come to possess a traditional importance which is questioned only occasionally. Whenever the votaries of a fresh subject have to get recognition for their subject, which they think is highly cultural and educative in its study, they have to establish its special utility. Generally it should have been an acknowledged principle that any branch of study which provides an intellectual training should have a place as an optional subject in the educational system. But because the educational system, like other aspects of our social life, has a past such incorporation of a new subject is not an easy matter. I shall endeavour to put before you some considerations which should convince our educational authorities of the great importance and utility of our subject from the social point of view. In doing this I take it for granted that, though the study of the subject is in its childhood in our country, its suitability for intellectual training is not questioned.

Two of the early great anthropologists of England, who expressed their opinions on the utility of this subject, conceived of its two different uses, one restricted and imperial and the other wide and humanistic. It was urged by Dr. Flower that a sound knowledge of the customs, beliefs, and manners of the backward peoples whom British colonial officers had to govern would be very useful in administering the areas under their charge peacefully and to the good of the 'natives'. Tylor on the other hand stressed the importance of the study of Anthropology in enabling us to guide the world in such a way as to leave it better. The need of anthropological training in the business of administration was clearly felt by some of the great Colonial administrators, who consistently put this point of view before the proper authorities and the academic world. As a result of the combined efforts of these great administrators and of the leading associations devoted to the study of Anthropology in Great Britain, Anthropology has not only secured an honourable place in the Universities but has been practically recognized by Government. Trained anthropologists have been attached to many administrative machineries with distinct gain both to administration as well as to the 'natives' concerned. The probationers for Colonial and Indian Civil Services are required to go through a certain course of study in Anthropology, and both Physical and Cultural Anthropology may be

offered at the examination for entrance into these Services, though it is not as yet put on a footing of equality with other major subjects. Mr. J. H. Driberg thinks that the training provided for in the year of probation is not at all sufficient and urges that it ought to be spread over full four years.

In the present condition of our country Anthropology ought to prove useful in both these ways. There are a number of peoples, jungle tribes and others, whose assimilation in our civilization is one of the important problems awaiting solution. In order to be able to solve the problem their past and present condition must be carefully studied, their cultural affinities fully investigated. No doubt an amount of good material is already available. But the problem has not been authoritatively enquired into in the light of the material. It is time that an expert committee were appointed either by our Congress or by the Government to discuss this problem and to lay down a plan and a programme to be worked out with a view to ameliorate the condition of these peoples who have remained outside the main path of cultural development in our country. It is clear that the District and other officials who have to come into close contact with these peoples in their administrative capacities ought to have a good training in Anthropology in general and the ethnography of the specific area in particular.

The need for a study of Anthropology because of its other use is even greater in our country. I believe, as all educationists must, that knowledge sooner or later influences our attitudes and practices, to a greater or less extent. I have already dwelt on the liberalizing and liberating influence of a comparative study of culture. At the present juncture, when we are passing through a trying phase of contact with Western culture, a deep study of cultural process, the need for contact and interaction, and the cyclical nature of civilization ought to orient us properly towards the situation. It is accepted by a large number of our educated countrymen that there is much maladjustment in our social institutions, and anachronism in some of our religious beliefs and practices. It is also felt by many that one of the chief causes of the lack of unity between the Muslim and the Hindu sections of our nation is mutual ignorance of their respective cultures. A general study of culture thus becomes a national necessity with every educated Indian. It therefore ought to find a place in our University curricula. It is well known to you that many of our social reformers when they suggested certain reforms in our social customs and religious beliefs appealed to—and there are many who still appeal to—the old scriptures and tried to gain support for their ideas by interpreting the scriptures in such a way as to uphold the ideas they wished to promulgate. In so far as such an attitude assumed that many of the desirable reforms were only our ancient customs and beliefs enshrined in the

scriptures but latterly misinterpreted it engendered—and even now it does so—a firm belief in the minds of laymen that our scriptures are all-comprehensive and we need not go outside them for reform. It strengthened and strengthens the common belief that our scriptures are infallible. If the reformers interpreted the scriptures in a manner to uphold their views scores of Pundits could vouchsafe for the accepted and routine interpretation which fully endorsed the current practices and beliefs. Laymen already very favourably biased in behalf of their customs, were and are swayed by the interpretations of their beloved Pundits. The result is that in spite of the splendid endeavour of the many high-souled and earnest reformers the desirable reforms have been very slow to come into practice. I firmly believe that the right method of approach towards the problem of social and religious reform is not by way of an appeal to a fresh interpretation of scriptures but by way of presenting to all educated people—and through them at secondhand to even the uneducated ones—a comprehensive picture of social institutions, customs, and religious beliefs of peoples of different climes and times and of various stages of cultural development. It is only when our educated brethren are armed with a comparative study of this kind that some of them at least will develop a proper attitude towards our existing customs and beliefs. All those, therefore, who will have the chance of leading public opinion in howsoever a small area and in whatever capacity—whether as a taluq-officer or as a political leader or as a social worker—should have made a comparative study of social institutions and religious beliefs. I submit that the end can only be achieved if this aspect of Anthropology is made compulsory in many of our courses of study for various examinations.

The considerations set forth above have led me to the opinion that the examination for the recruitment to Civil Services ought to have certain subjects compulsory and of these at least the two aspects of Anthropology—viz. a general study of culture and a comparative study of social institutions and religious beliefs—must be one. Similarly to achieve the objective they ought to be introduced, along with some other social sciences, as compulsory subjects in Degree-courses which pertain to non-specialized examinations.

Section of Anthropology.

Abstracts.

1. The antiquity and origin of the wheel with special reference to India.

P. MITRA, Calcutta.

The wheeled cart in Mohen-jo-daro and other examples of wheeled vehicles in early antiquity. The stages of wheel structures in India from block wheel to spoked wheels of various types. The survival of wheel-less carts in peripheral regions of India. The use of the wheel also as a weapon in India. Possible origin of the wheel from neolithic ring-stones as much from rolled trunk models. The possible uses of the so-called massive mace-heads of Mohen-jo-daro as primitive roller wheels in imitation of rolled trunks.

2. Analysis of racial likeness in Bengal castes.

P. C. MAHALANOBIS, Calcutta.

This paper gives a general biometric analysis of the degree of racial likeness among different Bengal castes based on Risley's data as scrutinized and revised by the author.

3. Tardenoisian implement types from Sabour.

SUSANTA BOSE, Calcutta.

Capsio-Mesolithic flint implements found in 1931 in Sabour in the district of Bhagalpur. They are made of orange, green, crimson coloured stones of Chalcedon group, and transparent, translucent, and opaque quartz crystals. Their sizes vary from 5 mm. to 4.56 cms. The following types could be observed: Microlith triangulaires, Microlith rectangulaires, Microlith prismatique, Micro-grattoirs, Micro-racloirs, Micro-beq-de-parroquet, Micro-burin-appointe, Micro-burins, Micro-beq-de-flute, Micro-chisels, Arrow-heads, Hameçon, Polyhedric-plaining-tool, points, Grattoir nucleiform, Lame-a tranchant rabattu, Crescents, double and single, nucleus. These are comparable with types from Europe, Africa, China and other parts of India; notably from Singapore site.

4. Traces of Darwin's tubercles in the ears of peoples of North and East Bengal.

B. N. Datta, Calcutta.

In this paper the result of observations on the subjects examined from North and East Bengal having 'Darwin's tubercles' in the ears is given. The subjects are all males and of adult age. The total number of subjects examined from North and East Bengal is forty-seven. Out of this, twenty-one subjects show traces of 'Darwin's tubercles' in the ears. Of these, five subjects have the tubercle in the right ear, one has got it in the left ear, the remainder show it in both the ears. Out of the total subjects, 42.5% have the tubercle in their ears. It is to be found among all the castes and religious groups living in the regions mentioned in this paper.

Darwin's ear-point or tubercle is to be found on the edge of the helix of the ear.

5. Juridical ethnology of Nagas, Kukis, and the Meithei—a comparative study of the administration of justice.

S. SINGH, Calcutta.

The paper deals with the main principles of administration of law and justice among the Kukis and the Naga tribes in the North-Eastern border of Assam. The Meithei system is taken as the standard of comparison where the territorial principle is predominant in the organization of justice. It is contrasted with the kinship principles in work among the Angami Nagas and the Kukis.

6. An ethnic analysis of the culture-traits in the marriage customs as found among the Radhiya Brahmins of Mymensingh.

NIRMAL CHAKRAVARTI, Calcutta.

The eight forms of marriage recognized by the makers of Hindu Law, and the modes of marriage as described by modern anthropologists: distribution of Asura, Gandharva, and Rakshasa marriages. A detailed study of the marriage customs among the Radhiya Brahmins of Mymensingh. Analysis of the marriage ceremony into thirty-one main traits and their component sub-traits, and an enquiry into the Indo-European, Indo-Aryan, and Austro-Asiatic elements in them.

7. Sonkoli : a physical study.

G. M. KURULKAR, Bombay.

A statistical statement of physical measurements on one hundred males and fifty-three females of the Sonkoli caste : thirty-three measurements on the head, forty-three on the trunk, and sixteen on the extremities, with fifty-two indices worked on their basis.

8. Prehistoric discoveries in the Raichur district : Ternslides with remarks.

L. D. MUNN.

9. Some material cultures common to India and Polynesia.

J. K. GAN, Calcutta.

A critical study of the following culture traits : Habitations, e.g. apsidal hut, rectangular habitations, pile-dwellings ; cooking with heated stones ; canoe-burial. A distribution map is annexed with it.

10. Folk-art of women in Bengal.

J. K. NAG, Calcutta.

A cultural and geographical study of the naturalistic and geometric *alpana* designs. Its relationship to the primitive art of Chota Nagpur discussed. Functional associations of different designs.

11. Psycho-analytic interpretations of head-hunting, and other primitive customs with special reference to Indian condition.

P. CH. DAS GUPTA, Calcutta.

Methods of application of psycho-analytic principles in Anthropology discussed. Special analysis of head-hunting. Avoidances examined from the Freudian standpoint. Suttie rites analyzed. Wish-fulfilling dream factors in some primitive mythology and folk-lore.

12. Further studies of the Bengali profile.

P. C. MAHALANOBIS, Calcutta.

Detailed measurements of profile photographs of Bengali students are discussed in this paper. All the photographs were taken with the photographic Profiloscope designed by the author and described in a previous communication.

13. On the geographical distribution of several types of *Bagh-bandi* in Bengal.

J. M. DUTTA, Calcutta.

There are 8 types of *Bagh-bandi* or tiger-play prevalent in Bengal. The games are described, and their geographical distribution within Bengal, i.e. which type is prevalent in which locality, is shown.

14. Somatometric system of the Hindus.

J. N. GHOSH, Calcutta.

An elaborate system of measurements on the human body are to be found in many Sanskrit texts mainly for the purpose of dancing, painting, iconography, sculpture, and astrological *lakshmana* of various types of men.

The adult at about the age of 25 was preferred for measurement. About 72 measurements of the different parts of the human body were taken. The arm-span or *Vyayama* was the standard of measurement. Some of the human types into which classification was made were tribal names.

The study can be traced to *Vasista* and *Nagnajit* the well-known sage of the Rigveda and the father of a king of Gandhara mentioned in Satapatha Brahman respectively.

15. Clan-grouping in Assam.

J. K. BOSE, Calcutta.

The existence of clan-grouping amongst the studied Kuki, Naga and other tribes analyzed and the relationship of dual organization and tripartite divisions discussed on the basis of genealogical tables and terms of kinship collected in the field.

16. Change of culture amongst the Plains Garos.

J. K. BOSE, Calcutta.

The Plains Garos of Mymensingh are taken as the subject. Their whole life is modified except their social customs in which too some outer influence can be seen if a study of the Hill Garos are made. The Plains Garos are the most degenerated lot and their physical characteristics greatly differ from their Hill brethren. They have imbibed the influence of the Christian Missions and they have also to follow some conventions of the Hindu society as they have to work under their guidance.

17. Anthropometric study of the Bansphors.

MINENDRANATH BOSE, Calcutta.

Bansphors, a small nomadic group in Bengal. 50 measurements taken and analyzed.

18. An enquiry into foot and stature correlation of people of Bengal.

B. N. DATTA, Calcutta.

An attempt is made in this paper to find the correlations between the foot-length and stature, also the foot length-breadth index and the stature of 113 persons from different parts of Bengal. The data are taken from the writer's somatic measurements of the persons. They are adults and of all religions and castes.

The foot-length average is 24.62, standard deviation is 1.4, coefficient of variation is 5.6. The correlation of foot-length and stature shows that the majority of persons numbering 63 with 19-28 cm. foot-length range are medium-statured, the next largest group is formed with the same foot-length range by tall peoples, while persons with 19-26 cm. foot-length range and 137-158 cm. stature are short-statured. The correlation shows a tendency to combine higher stature with higher size of the foot.

The foot-index is taken by applying $\frac{\text{foot-breadth} \times 100}{\text{foot-length}}$ formula, average index is 37.46, standard deviation is 2.5, coefficient of variation is 6.8. Here, as above, variation is not great. The correlation between foot-index and stature shows the majority to be medium-statured with foot indices ranging from 36-46 cm. Then come the short-statured and tall peoples in equal numbers though with different foot-index ranges.

The foot-length and stature index being in vogue to find out the foot-length in relation to stature, the same is used here. The average stature of 113 subjects is 163.71, standard deviation is 1.27, coefficient of variation is 7.76. By applying the foot-length-stature index we get the average of 15.03. This average is fractionally smaller than that of the relative foot-length of the Indians measured elsewhere previously by others. Thus the Bengal subjects are on the average medium-statured and have relative foot-length not much removed from the peoples of other parts of India.

19. Anthropometrical studies of the Marrings of Manipur.

J. K. BOSE, Calcutta.

The Marrings are linguistically classed as Nagas while according to Brown and McCulloch, they are neither Kuki nor Naga but a new stock different from the both. Our field-work amongst them clearly brings out that they have absorbed in their customs various Kuki and Naga traits on a structure fundamentally their own.

Hundred adult males have been measured from different villages to find their affinity with the Kukis and the Nagas. Sixteen different measurements were taken on each individual following the method of Martin. The details are discussed in the paper.

20. Social organization of the Marrings of Manipur.

J. K. BOSE, Calcutta.

The most interesting feature of the social organization is their terms of relationship. This system is in the midway between the descriptive and the classificatory system. The regular form of marriage is by service and polygyny is rare among them. The dead are buried outside the village and a ceremony is performed a month after the death. Death from unnatural causes is much feared and they are buried in a separate cemetery. They have to perform a number of ceremonies to attain social distinctions and in all these sumptuous feasts are given to the villagers.

21. Beads associated with Tardenoisian implements from Sabour.

SUSANTA BOSE, Calcutta.

Beads found along with the mesolithic flint implements in Sabour in 1932 in Bhagalpur district. They are made of various stones of Chalcedon group. Quartz, Marble, Opal, Carnelian, Agate, white stones; beautiful banded stones of various colours. There are some perforated and painted beads—square, band, dots, cross-boundary paintings and band-paintings are available. The beads could be grouped into various stages of making from a crude flaked stone to a polished, painted and perforated bead. The types are oval beads, barrel-shaped beads, square beads, rectangular beads, elliptical round beads, elliptical divergent beads, square cylindrical beads, hexagonal barrel beads, circular thick beads. The painted beads show similarity of technique and design with Mohen-jodaro and other Indian types.

22. Studies in Santal's hair.

J. K. GAN, Calcutta.

A microscopical examination of Santal's hair. Cross-sections, pigmentation, thickness, etc. have been studied. A comparative study has also been made with other tribes in India and Oceania.

23. A Mal-Paharia colony in Murshidabad and processes of culture change in it.

J. K. NAG, Calcutta.

A slow process of assimilation of Hindu and Mahomedan cultural elements by this primitive tribe of the Rajmahal Hills.

24. Racial correlations between polynesians and diverse racial type in India.

T. C. RAI CHOUDHURY and S. SINGH, Calcutta.

Polynesian racial types compared with samples of Austro-Asiatic speaking groups in Chhota Nagpur, Caucasian dolichocephals and brachycephals of Northern India and some Mongoloid brachycephals of Assam.

25. A preliminary study of the interrelations of vital capacity with certain body measurements of Bengali students.

A. CHATERJEA, Calcutta.

The vital capacity, height, weight, chest measurements (chest circumference, chest volume, body surface area) of over 1,900 Bengali students between the ages eight and twenty were taken. Their interrelationships have been calculated and the averages compared with similar data found by other workers. The influence of age has been shown.

26. Khasi female measurements.

T. C. RAI CHOUDHURI, Calcutta.

50 subjects measured and statistically analysed.

27. Some primitive totem concepts as guardian angels.

S. SIRCAR, Calcutta.

An analytic study of the primitive attitude towards totem-guardian angels bereft of later conventionalized modes of thought with special reference to the bear as a guardian spirit.

28. A preliminary study of the blood groups of Bengalees.

R. BOSE, Calcutta.

200 samples analysed with their bio-chemical index.

29. Biometric study of fossil human skulls.

S. SIRCAR, Calcutta.

Some application of co-ordinative principles in finding out the function of the growth and form of human skulls from skulls of fossil men and primates.

30. The theory of the Divine Right of Kings.

J. C. DE, Colombo.

The theory of the Divine Right of Kings is discussed in the light of some Indian and Ceylonese evidence. The tradition about Bibhishana is particularly analysed.

31. The Bhils of Khandesh.

G. AHMED KHAN, Aurangabad.

Name and Origin :—‘Bhil’ is a Dravidian word derived from *Vil* meaning bow and arrow. Legends and traditions, though varied and interesting, agree in one respect that the Bhils were once despised and exiled people.

Racial Characteristics :—Marked Characteristics of the mixed Caucasian and Australoid are visible. Dark complexion, high cheek bones, wide nostrils and swarthy thick lips are striking features of the indigenous Bhil.

Clans :—The Bhils are divided into numerous totemistic clans known by names of trees, animals and places.

Dress, Food, and Occupation :—Man is scantily clothed bordering on nudism, and woman’s is in evolutionary stage. Silver and brass earrings are the favourite ornaments of both men and women. People in wild state live on berries and edible leaves and roots. Liquor brewed from *Mohwa* flower is indulged in. Hunting with bows and arrows is the favourite occupation of the hill Bhil, while women excel in the use of slings.

Musical Instruments :—The Bhil is more musical minded than any of the hill people in the South and Central India. Ingenious stringed instruments are skilfully used. Dancing is a favourite pastime on occasions.

Religion :—The Hindu pantheon has furnished them with a quota of special gods.

Islam has many votaries. In the wake of the Moghal invasion of the Central India many Bhils employed in the Commissariat embraced the religion of the invaders. Bhil women were in the keeping of Moghal soldiers and their offsprings added to the number.

Holi and *Dasera* are celebrated. The Bhils are extremely superstitious.

Language :—They speak the language of the people with whom they happen to live and mix, for example Mahratti, Gujrati and Hindustani.

Section of Agriculture.

President :—DR. F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S.

Presidential Address.

INDIAN AGRICULTURE AND PLANT BREEDING.

The improvement of the produce of the soil and the consequent improvement in the conditions of rural life in India is the objective of every agricultural department in India. In the various departments of agriculture, workers in all branches of agricultural science—chemists, plant pathologists, entomologists, bacteriologists, botanists, and agriculturists—have each contributed to the mass of knowledge which we possess to-day, and we are only just realizing that, if we are to exploit to the fullest economic advantage the results of scientific investigations in agriculture, we must add to the work of these specialists the labours of officers concerned with the investigations of marketing—the organization of production and exchange.

It is impossible within the limits of a Presidential address to attempt a survey of all the work which has been done in India for the improvement of the produce of the soil. In its widest aspect this would include a survey of the cattle problem and of the Indian dairy industry—for cattle and milk are almost as much the produce of the soil as a crop of grain. I propose in this address to deal only with improvements in Indian crops which have resulted or may result from the work of the plant breeder. Some years ago this Congress had the privilege of hearing a very able address on this subject from the late Mrs. Gabrielle Howard who gave us a broad general survey of the principles of plant breeding. To-day I shall indicate some of the major problems which are engaging the attention of the plant breeder in India and which are likely to yield results of economic importance.

The work of the plant breeder has for its object the improvement of agricultural produce either in quality or yield. At the present time when prices of agricultural produce are low the improvement of the quality of agricultural produce offers a more promising field of research, in the economic sense, than the production of high yielding varieties. It is, however, not possible to draw a sharp line of demarcation between these two goals of the plant breeder.

Improvement in the quality of a crop may result from the production of a type which is resistant to disease and the reduction of the loss due to disease will inevitably be reflected in increased yields. Again, the labours of the breeder may result in

the evolution of types which possess a shorter life cycle than that of the established variety ; such a property will produce, in the case of a North India rabi crop, an extension of the area of the crop towards the South, where an earlier hot weather necessitates an earlier harvest, and consequently increased production. It is evident, therefore, that the present economic depression militates heavily against the chances of the plant breeder producing results of immediate economic significance. Notwithstanding this, however, steady progress has been achieved in India both as regards results of immediate importance and in laying the foundation for future developments for more prosperous times.

A field of work which has, until quite recently, been relatively neglected in India is the breeding of varieties resistant to disease. Varieties which possess various economic advantages in yield and quality and which also are said to possess disease resistance have been bred in considerable numbers, but the deliberate direction of a plant breeding investigation towards the production of a disease resistant type has in India been very rare. At Pusa recently we have succeeded in producing types of *rahar* (pigeon pea, *Cajanus indicus*) which are resistant to the wilt disease caused by *Fusarium*. These results have been published and further work, not yet published, has been carried out on the inheritance of the property of resistance to wilt.

We were fortunate to find among the 82 different types which make up the mixed country crop of *rahar* some types which were resistant and some which were extremely susceptible to the disease. A cross between a susceptible and resistant type has indicated that resistance depends upon the presence of, probably, at least 3 pairs of factors and has yielded the somewhat surprising result that none of the factors for resistance is linked to factors which are responsible for the inheritance of the more important morphological characters of the types. We have succeeded in producing hybrid *rahars* which are resistant to wilt disease but which possess the morphological characters of the type which is susceptible to disease. This is a point of practical importance as it means that it should be possible in this crop to combine any desirable morphological character with the property of resistance.

There is perhaps no crop in India with which the labours of the plant breeder have been so successful as with wheat. The striking success of the Pusa wheats bred by the Howards will be familiar to all of you. There is also perhaps no crop in India which sustains such heavy and consistent loss from disease as wheat does from rust. The efforts of plant breeders in India up to now have generally been directed towards producing heavy yielding varieties of good grain quality and such rust resistance as these varieties possess has been the result of good fortune rather than deliberate intention on the part of the investigator. Recent investigations in India upon the parasites which cause

this disease have suggested that India is fortunate in possessing a relatively small number of different races of these parasites and that their persistence from one wheat growing season to another takes place in the hills. This advance in our knowledge of the cause of the disease makes it possible to design a comprehensive scheme for the breeding of rust resistant wheats and this work is now being undertaken by the Imperial Department of Agriculture. The research will involve the testing for rust resistance of the established and important types of wheat grown in India and their crossing with various foreign varieties which possess the resistant property. The investigation is, of course, complicated by the fact that there is more than one strain of the parasite and that a variety of wheat may be bred resistant to one strain and susceptible to others. I shall not say more about this interesting subject as we shall have ample opportunity for discussing it in our symposium on cereal rusts.

Recent progress in wheat breeding in India has resulted in the production of races of wheat of high grain quality. The results of milling and baking tests carried out in the United Kingdom with Pusa wheats have shown that in a new type, Pusa 111, India possesses a wheat which is from the bread making point of view equal in quality to the best Manitoba wheat. Another new wheat, Pusa 114, is almost equal to Pusa 111 in quality and has the added advantage that it has proved disease resistant both in northern India and in Sind.

Oil seeds are a crop of great importance in Indian agriculture, and as a result of the Ottawa Trade Agreement Indian vegetable oils and oil seeds now enjoy substantial tariff preferences in the United Kingdom. To exploit fully the advantages of these tariffs, work on the improvement of oil seeds is essential and is in progress at various centres in India. Linseed is one of the oil seeds on which extensive investigations have been made with the object of producing a white or yellow seed of high oil content and good yielding power. White or yellow colour in the seed is preferred to brown as the lighter coloured seeds yield a white oil. Generally speaking it is believed that high oil content is associated with large size in the seed and because of this belief 'bold' seed commands a higher price than small seeded types. The types of linseed, however, which grow and yield well in Gangetic India are the small seeded types, and, with the object of producing a large seeded type capable of good yield in the Gangetic alluvium, crossing has been carried out between small seeded types which grow well in northern India and 'bold' seeded types which grow well in peninsular India. Numerous hybrids have been produced of high oil content and medium seed size. The work of selecting for such a character as oil content presents difficulties, as oil content is not perceptible to the eye and can only be judged by chemical analysis. It was therefore necessary to base the selection from hybrid

populations on other desirable characters, such as growing power and tillering capacity, and to hope that among selections made on this basis we should find some of high oil content. A slight guide to oil content was the observation that large size in the seed was generally accompanied by large size in the flower.

While the main object of the genetical research on linseed at Pusa has been economic, the work has yielded results of considerable scientific interest and the full scheme of inheritance of colour in the petal, style and seed has been worked out and published. Colour in the petal is due to the interaction of several factors and a type which is new to Indian linseed is a double recessive form with pink flowers produced by crossing among the Pusa types. By crossing this pink form with other types we hope to obtain a recessive which will lack all the known factors for colour in the petal, and which, since seed colour is linked with petal colour, may offer economic possibilities in the production of a suitable seed for oil. This is a typical example of the manner in which the purely scientific aspects of a genetical study may suddenly reveal an avenue for economic improvement.

The potato differs from most of the main field crops in that it is propagated vegetatively by means of tubers. A valuable plant can be propagated true to type, no matter how heterozygous it may be. Coupled with this advantage, however, is the disadvantage that many diseases can be transmitted by tubers and the control of disease is more difficult than in the case of seed-propagated plants.

The present situation of potato growing is unsatisfactory. All the potatoes in general cultivation outside South America appear to have been derived from one or two varieties that were introduced into Europe in the 16th century. The number of varieties was increased by selection from seedlings and by crossing but with such poverty of initial breeding material it is hardly surprising that little real progress has been made. The problems of blight (*Phytophthora infestans*), virus diseases, etc. remain unsolved and, in fact, a *cul de sac* was reached. But with the discovery by the Russian Expedition to South America—and the succeeding American and German Expeditions—of a large number of both wild and cultivated species, some of them possessing characters exceedingly valuable from the breeding view-point, the outlook has changed entirely and it is now possible to take a more hopeful view of the future of potato growing.

In India the problem is peculiarly complicated. In the plains during the hot weather the grower loses the greater part of his stock owing to rotting caused by various fungi and bacteria; no really satisfactory method of storage, which is at the same time commercially practicable, has yet been evolved. An even more serious difficulty is that after two or three seasons in the plains potato varieties appear to 'degenerate'—doubtless largely due to the virus diseases which are so common in the

potato—and the cultivator has to obtain a fresh seed supply from the hills, paying heavy freight on this. In the hills the crop is liable to blight from which the crop in the plains is fortunately generally free. Again, in those parts where two crops in the year are taken the tubers from the one crop cannot be used as seed for the other, unless there is an interval of about two months, as the potato tuber exhibits dormancy.

It will be clear from the above that there are many difficulties to be surmounted in effecting potato improvement in India. Up to now almost nothing has been done in this direction, practically all the previous work on this crop having been limited to storage problems. Recently, however, a comprehensive scheme of research and breeding at Pusa and at a sub-station in the hills, with the aid of a grant from the Imperial Council of Agricultural Research, has been drawn up. This embraces: (1) The study and classification of the varieties usually grown in India; (2) The procuring of South American potato material and the crossing of this with the best Indian varieties in order to produce new varieties possessing desirable qualities such as immunity or high resistance to blight, resistance to virus diseases, etc.; (3) The study of the factors influencing flowering and fruit development, for it is well known that fruit formation and seed-setting in the potato is usually poor—a knowledge of this and allied problems is necessary for successful hybridization; (4) The possibility of breaking dormancy in the tuber by simple chemical or mechanical treatments has also to be investigated.

No account of modern progress in plant breeding in India could be complete without a mention of the achievements of the plant breeder in the improvement of the sugarcane. Sugarcane like potato is a crop which is vegetatively propagated and in this sense offers a relatively easy problem to the plant breeder with the accompanying disadvantage of the ready perpetuation of disease in the so-called 'seed'. The advantage lies in the fact, of course, that a desirable hybrid can be readily propagated without being fixed in the Mendelian sense. Six years ago this Congress had an able exposition of this subject from Rao Bahadur Venkataraman in his presidential address. Since that date, while progress in the economic sense by increasing the area under improved varieties has continued on an increased scale, the most interesting work from the point of view of a Science Congress has been the intergeneric hybrids produced at Coimbatore by crossing sugarcane with Sorghum. It is at present too early to say definitely whether these new hybrids will have economic importance: one of them Co. 352 appears very promising under Coimbatore conditions, ripening in 6-7 months and maintaining its juice for another 3 months. The recently established cytological laboratory at Coimbatore will undoubtedly find interesting material in this intergeneric cross.

This leads me directly to what has been up to now the most serious gap in our genetical and plant breeding research in India. I refer to the lack of cytological investigation upon the material with which plant breeding research has been carried out. The physical mechanism of heredity lies in the cell and its chromosomes, and a wealth of material awaits the investigator who can study the numerous crops which have been and are now the subject of genetical research in India. The Central Agricultural Research Station, now at Pusa and soon to be at Delhi, is shortly adding cytological section to its numerous activities. But there is a large field of work, and while plant breeding owing to the years of time and the area of land which it requires is difficult to prosecute in many Indian universities, the cytological side of genetical research is one in which we may hope for fruitful results from co-operation within the universities.

There is one aspect of the plant breeders' work which we, who labour for agricultural improvement in India, should not lose sight of. We, who are botanists, may produce a heavier yielding variety of a crop, but there is a limit to the productivity of the soil as it is generally cultivated by the ryot, and therefore improved methods of cultivation must accompany the introduction of improved varieties if we are to maintain the fertility of our lands. The labours of all of us in all our respective branches of science are equally important in the advancement of the oldest and most important industry in India.

Section of Agriculture.

Abstracts.

AGRICULTURAL STATISTICS.

1. A study in co-variance with fodder crops.

S. S. BOSE and S. C. SEN GUPTA, Calcutta.

Napier grass was grown under six manurial dressings in 6 randomised blocks at Dacca. The harvest was gathered in three instalments in December (1932), May, and September (1934). The sampling errors calculated from the analysis of variance in the three cases were 6.0 p.c., 4.8 p.c., and 3.8 p.c. respectively. The first and second cuttings showed a residual correlation +0.63 based on 25 degrees of freedom and this reduced the second year's estimate of error from 6.20 lbs. per plot to 4.96 lbs. But second and third cuttings showed very small correlation and thus did not produce any appreciable improvement in the estimate of error.

2. A complex cultural experiment with rice.

P. C. MAHALANOBIS, S. C. CHAKRAVERTTI, and
S. S. BOSE, Calcutta.

An elaborate experiment was laid out in 405 plots to test the effect of the date of planting, the extent of spacing and the number of seedlings per hole separately and in combination on three varieties of rice—one early, one medium, and one late. The lay-out was a balanced randomisation satisfying orthogonal conditions, and the yields gave clear evidence of significant first, second as well as third order inter-actions among the cultural treatments. The experiment is being continued this year.

3. The effect of different forms of harvest on the estimated error of field experiments.

S. C. CHAKRAVERTTI and S. S. BOSE, Calcutta.

The influence of border effect on the estimate of error in field experiments is well known. An experiment was designed to study the estimate of error for different methods of harvest. The methods used in the present investigation were (i) fields including border, (ii) fields excluding border, (iii) central area, (iv) the outer row of border, and (v) the second row from outside. The errors have been calculated in each case and the bearings of these have been discussed in relation to field experimentation.

4. Studies in tiller-formation.

K. C. BANERJEE, P. R. RAY, and P. C. MAHALANOBIS,
Calcutta.

A uniformity trial with *Jhingasail* rice was conducted in three 5 × 5 Latin Squares. Each plot contained 9 rows of 10 plants, i.e. 90 plants. The number of tillers in each individual plant was counted and the frequency distribution of these tiller counts have been studied in detail. The tiller obeys an approximate normal distribution and the mean tillers have usually been found to lie between 6 and 8. The effect of systematic fertility changes on the tiller formation has also been discussed.

5. Uniformity trial with rice in Karimganj farm.

S. S. BOSE and P. M. GANGULI, Calcutta.

Two Latin squares of size $12' \times 12'$ have been harvested and the standard deviations of yield per plot have been calculated for 25 different combinations (a) without eliminating the systematic soil-differences between rows and columns and (b) after elimination. The S.D.'s have been reduced to a constant plot size for comparison and as usual, the smallest plot size ($5' \times 5'$) has been found to yield the highest precision (6.3 p.c.), i.e. with 4 replications, the standard error would be very nearly 3 p.c. The frequency distribution of yield data is not significantly different from normal.

6. A note on the application of multiple correlation for estimating the individual digestibilities of a mixed feed.

P. C. MAHALANOBIS and S. S. BOSE, Calcutta.

The digestibilities of a mixed feed in an animal nutrition experiment are usually obtained by calculating the digestibility of one of the feeds given singly and then assuming this to be the same in the mixed feed given to the animals. This procedure has been found objectionable by some workers and sometimes yields absurd results, e.g. negative digestibility. In this note, the individual digestibilities of the mixed feed have been directly estimated by the method of multiple correlation; results obtained so far appear to be highly satisfactory but this requires further experimental test.

7. A statistical study of the yield under permanent manurials in Pusa.

S. S. BOSE, T. V. G. MENON, and P. C. MAHALANOBIS, Calcutta.

The yields of maize, arhar, and oats in the permanent manurial and rotation experiments at Pusa for 22 years (1908-1929) have been analysed in this paper. The effect of the treatments has been discussed and the influence of seasonal changes on the effectiveness of the manures has been brought out. Farm-yard manure has been found to be uniformly as good as the complete artificial manure for maize and oats while it was superior to the artificial manure for arhar. In point of residual effect also F.Y.M. is superior to the chemical fertilisers.

8. A statistical study of soil-deterioration in the permanent manurial experiments in Pusa.

T. V. G. MENON, S. S. BOSE, and P. C. MAHALANOBIS, Calcutta.

The successive yields for 22 years in a Pusa manurial experiment have been analysed for investigating the soil deterioration under different manurial dressings. The maize yields under artificial manures exhibit a significant deterioration ranging from 2 to 7 p.c. of the mean yield while the arhar figures do not show any such steady decline. F.Y.M. in three different doses has given the lowest deterioration values of 1.1 p.c., 2.3 p.c., and 2.7 p.c. of the mean yield per year.

9. The standard wheat series of the agricultural farm, Cawnpore.

R. J. KALAMKAR, Poona, and SRIPAL SINGH, Cawnpore.

The paper deals with a statistical analysis of the yields of wheat on plots receiving uniform treatments during the period 1885-86 to 1913-14 at the agricultural farm, Cawnpore. The analysis shows interesting relationship between manurial treatments, mean yields and the variability of the yields.

10. A statistical study of results of Cawnpore permanent manurial experiments.

M. VAIDYANATHAN, New Delhi.

Descriptions of the 13 treatments applied to four sets of 13 plots during the periods 1883-1898 and 1899-1913. Descriptions of four rotations of crops adopted in the four sets :—wheat-wheat, maize-maize, wheat-maize, and maize-wheat. Order of efficiency of yields due to different treatments during successive quinquennia. Explanation of causes of variation in yields in different sets of plots, deterioration, slow changes and annual variation. Comparisons of variances (and co-efficients of variation) due to these causes for the several rotations, and the probabilities of the variances (two periods taken separately). Statistical examination of 'slow changes' in the yields of the several rotations on the basis of 'polynomial' values and their standard error. Examination of slow changes on the basis of seasons. Examination of 'local character' of slow changes. Mean yield and annual decrement in several plots due to several treatments arranged on the basis of contents of essential elements of plant food. Inferences regarding the comparative effects of several treatments. Examination of residual effects of manures on several rotations. Effects of the additions of gypsum, bone-dust, and super to organic and inorganic manures. Appendix explaining the statistical technique employed.

11. Statistical analysis of the results of manurial trials.

B. N. SARKAR, Patna.

In the statistical analysis of the results of manurial trials the cost of the manure is not generally taken into account. Field workers generally interpret the results in terms of the cost of manure and value of produce obtained but no account is then taken of the standard of error. A simple formula is proposed for a test of what may be called 'agronomic significance', viz.,

$$\alpha = \frac{\Delta - 3n}{\lambda}$$

where

Δ = the market price of the difference in yield at prevailing rates between any two treatments;

λ = the difference in the cost of the same treatments;

n = the market price of the produce equivalent to the standard error of the mean;

and α stands for agronomic significance.

When the value of α is a positive quantity, the difference is both statistically and agronomically significant. And the treatment that gives the greatest positive value for α when compared with the control is the most profitable under the conditions of the experiments.

12. The statistical analysis of the results of yield trials.

B. N. SARKAR, Patna.

In the statistical analysis of the results of yield trials the relationship of Fisher's method of analysis of variance, Engledow and Yule's method of calculating the error of mean difference and the writer's method of estimating the error of differences from his 'normal fertility curve' is shown. Two alternative formulæ, viz. :—

$$\epsilon_m = \sqrt{\frac{S(v)^2 - S(p)^2 \cdot k}{n(n-1)(k-1)}}$$

and

$$\sqrt{\frac{k(6\sigma^2 - 6\rho^2)}{(n-1)(k-1)}}$$

for calculating the standard error according to the method of analysis of variance for trials conducted in randomised blocks are given.

AGRICULTURAL METEOROLOGY.

13. Precision observations on weather and crops.

L. A. RAMDAS, R. J. KALAMKAR, and K. M. GADRE,
Poona.

The present paper outlines a scheme of precision observations on crops and discusses the results obtained in the case of wheat during the rabi season of 1933-34 at the Agricultural College farm, Poona. The micro-climatological and other contemporary meteorological factors recorded during the above season are also discussed. Similar studies are being continued in the case of 'Jowar' at Poona and in the case of 'Rice' at Karjat (in collaboration with Mr. Kadam, Crop Botanist) during the kharif season of 1934. The importance of such observations at selected centres in the case of the major crops is emphasized.

14. Studies on micro-climatology—the humidity factor in micro-climates.

L. A. RAMDAS, R. J. KALAMKAR, and K. M. GADRE,
Poona.

The paper summarizes existing knowledge on various meteorological factors that may be derived from the usual measurements of dry and wet bulb temperatures. This is followed by a discussion of the variation of humidity in different micro-climates as studied at Poona and their importance in plant life.

15. Studies on soil-moisture in relation to moisture in the air layers near the ground.

L. A. RAMDAS and M. S. KATTI, Poona.

Experimental investigations at the Agricultural Meteorological Observatory at Poona show that during the clear season there is an interchange of moisture between the soil surface and the air layers near the ground. The soil loses moisture during day due to evaporation and recoups this loss at night by absorption of moisture from the air layers near the ground. Daily observations in the case of the local soil as well as hourly observations of evaporation by day and absorption by night in the case of different soils are briefly discussed. Each type of soil has its own characteristic variation.

16. Studies on the incidence of frost in India during the winter season.

L. A. RAMDAS and A. ANANTHAPADMANABHA RAO,
Poona.

Many parts of North India are liable to frost in winter. These frosts are usually associated with the clear weather which succeeds the passage of the western disturbances of this season across the country from west to east. The incidence of frosts is often followed by considerable damage to crops. Charts showing the statistics of occasions when temperature fell below the freezing point near the ground at a few representative stations in India have been constructed. Details of frost damage during the winter of 1933-34 together with the attendant weather factors are also discussed.

17. A study of the dates of onset of the South-West monsoon.

L. A. RAMDAS and V. SATAKOPAN, Poona.

The date of onset of the S.-W. monsoon is of great agricultural significance. As a preliminary to a detailed statistical examination of the subject the dates of onset and the nature of the distribution of the daily rainfall over the Travancore-Cochin area for the months of May and June were studied in the case of each of the last 42 monsoons. The analysis shows interesting results.

18. Soil cover in relation to soil temperature.

L. A. RAMDAS and R. K. DRAVID, Poona.

Two-hourly observations of soil temperatures at different depths in a control plot and in a similar other plot successively (a) bare, (b) covered with a thin layer of chalk, (c) covered with charcoal powder, and (d) given definite amounts of watering were taken during the clear season of 1933-34 at the Agricultural Meteorological Observatory, Poona. These data reveal profound variations in the temperatures of the treated plot from those in the untreated control plot. The results are discussed.

19. Adsorption of moisture by soil surfaces in relation to the heat of adsorption.

L. A. RAMDAS and P. K. RAMAN, Poona.

The study of the heat of adsorption in relation to the quantity and rate of adsorption may offer a useful method of investigating the behaviour of different soils. The authors have designed a simple instrument for the measurement of the heat of adsorption. Some results obtained with this instrument are described.

20. A study of (i) the total radiation from the sky and the sun during day time, (ii) the radiation from the night sky, and (iii) the albedo of different types of soil surfaces.

P. K. RAMAN, Poona.

The study of radiation from the sun, sky, as well as the earth's surface is of fundamental importance. The paper describes the standard instruments used for measuring these elements and discusses the data collected so far at the Agricultural Meteorological Observatory, Poona.

21. A portable standard thermo-couple set for measurement of plant temperatures.

N. M. ATHAVALE and A. ANANTHAPADMANABHA RAO,
Poona.

A portable standard thermo-couple set for field measurements of plant temperatures has been constructed. The instrument provides a dozen thermal junctions and may be used in conjunction with a portable sensitive galvanometer or with a suspension coil galvanometer installed in a field laboratory. Some observations taken in a sugar-cane crop are described.

22. A portable percolation gauge for use in the study of effective rainfall.

M. S. KATTI, Poona.

A portable percolation gauge having the same diameter as the standard Symons rain-gauge has been designed. The instrument is provided with a suitable receiver and a protecting collar outside to prevent external spray getting into the receiver during rain. A series of gauges containing soil 6", 1 ft., 1½ ft., 2 ft., etc. deep is exposed in the Agricultural Meteorological Observatory at Poona. Results obtained during the rainy season of 1934 are discussed.

23. Cotton yields in the districts of the Bombay presidency in relation to weather factors.

L. A. RAMDAS, R. J. KALAMKAR, and OTHERS,
Poona.

The yield data of cotton for the cotton growing districts of the Bombay Presidency during the last 43 years have been correlated with rainfall and temperature of the growing season, after elimination of secular variations. The relationships obtained have been utilized for predicting the yields. The results are discussed.

24. Cotton acreages in the districts of the Bombay presidency in relation to meteorological factors and the prices of cotton.

R. J. KALAMKAR, V. SATAKOPAN, and S. GOPAL RAO,
Poona.

The area sown with cotton in the various districts of the Bombay Presidency during the last 43 years have been correlated with the rainfall at sowing time and with the prices after eliminating secular variations. These relationships are discussed.

25. A statistical analysis of the soil temperatures recorded at Bombay.

N. RAJAGOPALAN, Poona.

Daily records of the soil temperatures at depths of 1", 9", 20", 60", and 132" were kept at the observatory at Colaba, Bombay, for a period of sixty-six years with effect from 1860. The monthly means of the above series have been statistically analyzed by the polynomial method of Fisher and it is observed that significant secular changes have taken place at all depths.

26. A note on the statistical analysis of rainfall of the Mysore State.

A. ANANTHAPADMANABHA RAO, Poona.

A statistical analysis of the annual rainfall in the Mysore state and its various districts extending over a period of forty years (1893 to 1932) has been made with a view to study the variability, the secular trends if any, and the rainfall correlations in the different districts.

On the basis of the above study, it has been possible to divide the state into three more or less homogeneous groups with respect to rainfall. Secular trends are relatively unimportant except in Kadur district.

27. A statistical study of maximum temperatures at selected stations in India.

R. J. KALAMKAR and A. ANANTHAPADMANABHA RAO,
Poona.

The paper is a continuation of the earlier work of the senior author in the case of Poona (vide *Indian Meteorological Department Scientific Notes*, Vol. V, No. 59, 1934). The analysis shows interesting relations between the periods of high inter-monthly correlations and the seasonal changes of weather in India.

28. On the possibility of using windmills for irrigation in India.

V. DORAISWAMY IYER, Poona.

The paper presents the available wind data and discusses how far the prevailing winds can be harnessed for driving windmills. An analysis of the winds in different parts of India shows that they are strong enough to drive windmills mostly along the coastal tracts and in the Deccan plateau, but that they are too weak for this purpose in northern India. The paper contains tables and charts which may be interesting to agriculturists.

AGRICULTURAL CHEMISTRY AND MICRO-BIOLOGY.

29. Leaching with water as a method for reclamation of saline soils.

V. A. TAMHANE and J. J. CHANDANI, Saktand-Sind.

Saline soils in Sind, which according to the present nomenclature could be called 'SOLONCHAKS', are seen as vast stretches of salt incrustations spreading over several miles. These also exist as small or big patches amongst the cultivated fields and as such could be called 'SOLONCHETZ'.

These saline soils contain large quantities of salts, e.g. sodium chloride and sodium sulphate, but sodium carbonate is rarely found. Besides the sodium salts gypsum is also present in the soils.

With the advent of perennial irrigation from the Lloyd Barrage in Sind the problem of reclamation of these saline soils has become very important due to the extension of cultivation. It was therefore thought necessary to study the different methods of reclamation and find out the method suitable to local conditions.

The results of the work on reclamation show that leaching the saline soils with 32.0" water given in 4.5 instalments at the intervals of 5-7 days and followed by suitable crops has proved to be a very successful and cheap method of reclamation. The amount of leaching dose and time taken for reclamation varies with the nature of the soil.

It is, however, observed that in the early stage of reclamation by this method the land reclaimed should not be allowed to lie fallow for a long time but should remain under crop as far as possible, or at least the fallow period between the two crops should be reduced to a minimum.

30. Agronomic adjustments of the cotton crop, in the Gang canal colony, Bikanir State, India.

SHAMSHER SINGH and YESHWANT D. WAD, Indore.

The inauguration of the Gang Canal Colony in Bikanir State, Rajputana, threw open 970 square miles of land for intensive cultivation. In the new agricultural economy of the tract irrigated, cotton holds a very large place. In addition to the choice of a suitable variety, the questions of optimum sowing date and the frequency and distribution of irrigations had to be decided. Two sowing date tests on the variety Mollisoni and one on Punjab 289 F and two irrigation tests on each of the two varieties conducted during 1932 and 1933 gave sufficient data to arrive at some main conclusions. The optimum sowing date for both the varieties seems to be about the middle of May. Though sowing of Mollisoni can be delayed up to the middle of June without affecting the yield, the lint quality and staple length seem to suffer slightly. The results of the irrigation tests suit Ganganagar conditions very well in that, according to scarcity or otherwise of the canal water, similar performance of both the varieties can be secured either by liberal or frugal irrigation adjusted to physiological needs. Frugal irrigation has given a better quality of lint. If scanty irrigation is given in the early stages it should be continued throughout the life of the crop and vice versa.

31. Effect of the decomposition of green manure on the growth and yield of paddy.

R. N. MISRA, Nagpur.

An account of pot culture experiments on the effect of decomposition of green manure on the growth and yield of paddy has been given.

Average yield figures of three years indicate:—(a) that the pots receiving green manure two weeks prior to the date of transplantation give definitely larger yields than those obtained from the plots receiving green manure one week before transplantation, (b) that the pots receiving green manure one week prior to the date of transplantation give larger yields than those obtained from pots receiving green manure just at the time of transplantation, (c) that all the pots receiving green manure, irrespective of the periods of decomposition, give better yields than those obtained from unmanured pots.

32. The preferential utilization of different forms of inorganic nitrogen in the decomposition of plant materials in the soil.

J. G. SRIKHANDÉ, Bangalore.

The decomposition of straw in both heavy and light soils in the presence of ammonia-nitrate mixtures has been studied. It is observed that the organisms appear to prefer nitric-nitrogen to ammonia-nitrogen in the heavy soil, whereas the reverse seems to be the case in the light soil. While working with pure plant products a definite preference for ammonia rather than for nitrate was observed during decomposition in the earlier stages when in contact with both ammoniacal and nitric-nitrogen.

33. Influence of the decomposition of organic matter on mineral transformations in swamp soils.

B. A. SUNDARA IYENGAR, Bangalore.

The influence of the decomposition of cane molasses on the dissolution of minerals has been studied. It has been found that in a swamp soil, there is progressive increase in the quantities of iron and aluminium passing into solution for the first one month, after which there is a decline. Iron in solution is mostly in the ferrous condition: the mechanism of reduction to that form would appear to be partly due to chemical and partly to biological agencies. After about five weeks, however, the iron in solution precipitates rapidly and is to be found in the surface layers of the soil mostly in the ferric condition. This would suggest that oxidation changes are involved in the later stages. The decomposition also leads to increasing quantities of calcium and potassium passing into solution, but unlike the iron and aluminium, they continue to remain in solution throughout the period of examination. There is no appreciable increase in the quantity of phosphorus passing into solution. The quantity of exchangeable calcium in the soil decreases with time while those of iron and aluminium increase with the progress of fermentation. The possible significance of these and related changes in relation to plant growth and crop yield have been discussed.

34. A study of the changes in the bacterial flora of different silages.

N. V. JOSHI, Pusa.

In previous years it has been found that some fodder plants such as berseem and *dhub* grass (*Cynodon dactylon*) if ensiled by themselves do not yield a good silage and that the addition of wheat or oat straw or molasses results in improving the product obtained after ensiling. A study of the changes in bacterial population of the different materials during the course of ensilage was made and it has been ascertained that the organisms of the *Aerogenes*—*Cloacæ* group are predominant in the early stages when berseem, *dhub* grass or Kudzu vine are ensiled by themselves, *Streptococcus lactis* appearing only in later stages. When wheat straw, oat straw or molasses are added to these fodders, however, the predominant organism from the start is *Streptococcus lactis*.

This difference in the kinds of organisms present in the initial stages of fermentation in the different silages appears to be dependent on the kind of food available for the bacteria present in the ensiled materials and is of great importance in the kind of fermentation set up.

This observation is of great use to persons interested in making silage, because it places at their disposal a means of getting a good quality of silage from materials which though available in abundance do not yield a satisfactory product when stored in the silage pit. A suitable alteration of the composition of the material is all that is necessary and this can be attained by the addition of wheat straw, and oat straw if available as surplus materials, or molasses which are at present running to waste in many sugar mills, to the highly nitrogenous materials like berseem or *dhub* grass, which by themselves do not give good silage.

35. Transformations of nitrates in water-logged soil.

SACHINDRANATH SIRCAR, Dacca.

Waterlogging of soils resulted in (a) the rapid disappearance of nitrate, (b) an initial increase in ammonia followed by a decrease. The addition of nitrate to the waterlogged soil brought about (a) an increased evolution of carbon dioxide, (b) a rise in the bacterial number. Nitrate

in waterlogged soil was neither reduced to ammonia nor denitrified. The disappearance of nitrate in waterlogged soil was the result of the assimilation of this substance by soil micro-organisms. When the proportion of the available energy material in the soil was in excess of the nitrate present, the latter was completely assimilated. When the energy material was decomposed by incubating the soil under optimum conditions and then waterlogged, nitrate suffered only slight loss. When the available C : N ratio of the soil was about 50 : 1, nitrate was completely assimilated but when the ratio was less, a part of the nitrate remained in the soil. In presence of the added plant materials nitrate disappeared more quickly than in the untreated soil. In cropped soil very little nitrate was lost in bottom drainage; but in the uncropped soil about 40 per cent. of the nitrate could be recovered in the drainage water. There was slow nitrification of the ammonium sulphate added to the waterlogged soil.

36. Nitrogen balance in the black cotton soils in the Malwa plateau. III, Changes during the Monsoon.

YESHWANT D. WAD and R. K. AURANGABADKAR,
Indore.

The course of nitrification characteristic of the *Kharif* season with its wet and dry spells is traced. The intensities were lower than those during the hot weather. Compared with the light sandy soil of Jaipur the heavy black soil of Malwa showed a slower rise to a maximum. The subsequent fall, however, was quicker in the sandy soil.

Nitrification in poor patches carrying meagre growth in the field was always lower and less intense than that shown by adjacent soils with better growth. These soils, though initially very uniform, developed a great heterogeneity during nitrification, thus suggesting that soil deterioration is the direct result of its own activities.

The intensities of nitrification were parallel to the accumulation of nitrates.

Fixation of nitrogen rose and fell like nitrification. Safflower cake increased nitrogen losses while compost had a steady influence on both soils. Jaipur soil showed a greater capacity for fixation than Indore soil. No appreciable fixation occurred in poor patches.

Capacity for crop growth and algal development varied directly with the quickness and intensity of fixation and nitrification, indicating the presence of a common factor. The possibility of their dependence on the presence of a humic derivative controlling soil texture is suggested.

37. Utilization of seeds and seed-cakes.

N. SRINIVASAN, Bangalore.

The coagulable protein can be separated by (a) extraction of the cake powder with crude alkali solution, (b) precipitation from the extract by organic acids produced *in situ* by fermentation with the aid of a biological starter (*Ind. Pat. No. 20143*). The vegetable casein thus obtained can be utilized in a number of industries (*Ind. Pat. Nos. 20192 and 20103*).

The removal of the protein leaves nearly 30% of the original cake (N : 2%) which when mixed with the supernatant acid yields half the quantity of a by-product manure of about the same Nitrogen content as the original cake. Pot culture experiments carried out on barley have shown that it can yield even better results than the original cake when used in quantities equivalent on nitrogen basis. This can be ascribed to the following facts:—(i) It is richer in minerals and soluble nitrogen than the original cake; (ii) It is free from oil and therefore capable of more rapid decomposition in the soil.

38. Determination of efficiency of apricot seed cake as a nitrogenous manure.

S. DAS, Pusa.

Although apricot seed cake is available in plenty in the neighbourhood of Solon near Simla Hills, it is neither used as a cattle-food owing to its bitter taste, nor does it find an alternative application as a manure; it is burnt as a fuel only. The cake containing a fair amount of nitrogen besides a good proportion of phosphate and potash, its waste as a fuel is an economic loss to agriculture. About 60 per cent. of nitrogen present in the cake may however be transformed into available forms.

With a view to find out the possible utilization of the cake as a nitrogenous manure pot experiments were carried out with three dissimilar types of soil, e.g., (1) a highly calcareous Pusa soil containing about 35 per cent. of calcium carbonate, (2) a non-calcareous Kalianpur soil near Cawnpore, United Provinces, containing less than one per cent. of lime, and (3) a hill soil from Solon near Simla Hills.

The cropping results showed that the application of 80 lbs. of nitrogen per acre in the form of cake produced the maximum yield of wheat in Pusa and Solon soils, and 100 lbs. in the case of Kalianpur soil. The results were found to be statistically significant. With different doses of the cake varying from 20 to 100 lbs. of nitrogen per acre, crop yields ranging from 85 to 155 per cent. over the control were obtained in Pusa soil, 94 to 300 per cent. in Kalianpur soil, and 19 to 94 per cent. in Solon soil. The residual effect of the cake was tried in Pusa soil only and was found to be existent for 100 lbs. of nitrogen per acre which alone gave statistically significant yield of *ragi* (*Eleusine coracana*) over the control.

A similarity of manurial effect was noticed in Pusa and Solon soils. Such effect was found in two applications of the manure, viz., 40 and 60 lbs. of nitrogen per acre in Kalianpur soil, but non-existent in the rest.

The cake being effective as a nitrogenous manure with an important crop like wheat in three dissimilar types of soil, it will undoubtedly prove an efficient nitrogenous manure for soils which are particularly deficient in this essential constituent, and especially so on agricultural lands in the neighbourhood of Solon near Simla Hills where it is available in plenty, but at present wasted as a fuel only.

39. The availability of superphosphate with depth of its placement in calcareous soils.

S. DAS, Pusa.

Experience shows that the application of superphosphate alone to calcareous soils, more often than not, yields disappointing results, and the best yields are usually obtained in conjunction with green-manuring. Superphosphate readily reacts with calcium carbonate normally present in calcareous soils, its water soluble P_2O_5 being precipitated as insoluble calcium phosphates and retained in the upper layers. The action of super is thus localized, which results in its restricted action in these soils. Therefore the failure to obtain a profitable response to superphosphate in calcareous soils may be partly attributed to the improper placement of the fertilizer. In consequence, should superphosphate be applied at different depths of such a soil, a variation in response is expected depending on whether the crop grown is a shallow-rooted or a deep-rooted one.

With this object in view a series of pot experiments was conducted with a calcareous Pusa soil containing about 33 per cent. of calcium carbonate, where superphosphate was applied to different groups of pots at surface, and 4, 8, 12, and 16 inches below the surface and also mixed throughout the soil. There was also a group of pots for comparison

where no phosphate was added. A basal dressing of potash and nitrogen was given to all the pots as sulphate of potassium and ammonium respectively. Mustard was grown, which is a shallow-rooted plant.

The cropping results showed that all the pots treated with superphosphate produced higher crop yields than the control. But the yields from the application of super at surface and throughout the whole mass of soil were of the same order and the least, when compared with other applications. The application of super at 4 inches below the surface, on the other hand, gave the maximum crop production which was found to be statistically significant, when compared with the mean yields of other treatments. Thus, the depth of placement of super plays an important rôle in a profitable crop response in calcareous soils.

Again, the total phosphate contents of 4 inches soil borings from pots of different treatments of superphosphate show that phosphorus does not leach downwards and largely remains at the depth where it is placed in the soil. This is fully in agreement with the observation of other workers.

40. Relative availability of different natural and artificial phosphates in calcareous soils.

S. DAS, Pusa.

Indian soils are generally deficient in available phosphates. Therefore in order to satisfy the phosphate deficiency in the best possible way a series of pot experiments was conducted with a calcareous Pusa soil having about 33 per cent. of calcium carbonate. Indigenous phosphates like bones, apatite and Trichi-nodules, as well as artificial phosphates of iron, aluminium, calcium, magnesium, sodium, potassium, and ammonium were applied to different groups of pots. A basal dressing of potash and nitrogen was given to all the pots as sulphate of potassium and ammonium respectively. There was a group of control pots for comparison, where no phosphate was added. Mustard was grown as the *rabi* (winter) crop.

The cropping results showed a higher crop return than the control with every phosphatic fertilizer, varying between 19 and 127 per cent. over the control according to the quality of the manures used. Natural phosphates and also aluminium phosphate rather produced a lesser out-turn in comparison with the rest of the phosphates. The manures used can be classified into four groups according to the magnitude of yields obtained.

A statistical examination of the results revealed a high significance over the control with every treatment except apatite and aluminium phosphate. Superphosphate and ammonium phosphate however gave the most significant results of all the manures tested.

Ragi (*Eleusine coracana*) was grown as the *khari* in the same pots in order to study the residual effect of these manures. Fresh weight of seedlings of about four weeks' growth showed a fair increase over the control with every treatment except Trichi-nodules, magnesium and iron phosphates which yielded negative results. The harvest of this crop is being watched with interest.

The examination of solubility or availability values of these manures by extraction with 2 per cent. citric acid solution showed some relationship between them and crop growth in the case of residual effect of five of these manures, but in the primary effect of the manures such relation was non-existent.

It is suggested that solubility is not the dominating factor of availability of phosphatic manures in a soil. But perhaps other factors like the feeding power of plants, biochemical activity of a soil, colloidal properties of manures, and base exchange phenomena play an important rôle in rendering different phosphatic fertilizers available in a soil.

41. Factors controlling nodule development in groundnut (*Arachis hypogaea*) sannhemp (*Crotalaria juncea*) and 'Dhaincha' (*Sesbania aculeata*).

K. L. KHANNA, Masheri.

Type of soil, kind of manure, spacing in rows, frequency of inter-cultivation, interval of irrigation, atmospheric weather and soil moisture content were found to exert considerable influence. Periodicity of nodular flushing was found to be more regular under irrigation than under rainfed conditions. High pH invariably suppressed nodule development in groundnut and sannhemp, though 'Dhaincha' showed a certain amount of tolerance. Phenomenon of shedding of nodules was observed in groundnut during protracted drought particularly at flowering stage and after a period of favourable leafy growth, largest number of colonies were observed just before the fruiting stage in all the three cases studied. Character and behaviour of nodules in culture solutions are described.

42. Studies in the dissociation of *Bacillus cereus*, an organism frequently associated with plants affected with the mosaic disease.

N. V. JOSHI and S. C. DUTT, Pusa.

An organism was found to be practically constantly associated with different kinds of plants, e.g. Tomato, Tobacco, and *Bhindi*, etc. which were suffering from the mosaic disease. The technique of isolation consists in (a) sterilizing the outside of the cut pieces of stems and petioles of leaves by 1 : 1,000 mercuric chloride solution, under reduced pressure, (b) washing the sterilized pieces with sterile water and placing them on sterile agar slants, and (c) selecting only such growth as occurred after an incubation period of 7 to 10 days, sometimes extending to 23 days. Any tube in which growth occurs before 7 days' incubation is rejected as being contaminated.

Inoculation with cultures obtained in this way into healthy plants gave positive results on many but negative ones on a few occasions. No definite explanation can be offered for this capricious behaviour of the organism.

It was considered, therefore, desirable to study this organism in greater detail before entering into the discussion of the causes of failures to reproduce mosaic disease on inoculation of healthy plants with cultures of this organism. The organism was identified as *B. cereus* which showed pellucid dots on agar cultures, the cause and origin of which dots had not been satisfactorily explained, some considering the dots to be the result of bacteriolytic principle or bacteriophage present in the agar cultures, others considering them to be 'the places where the culture is in virus form'.

Further studies on the subject in detail are given in the paper.

43. Bacteriological analysis of some samples of sand and silt thrown out by the recent earthquake.

N. V. JOSHI, Pusa.

Samples of sand and silt thrown out by the recent earthquake were collected very soon after the earthquake. The bacteriological activity in these samples was compared with the normal bacterial activity in Pusa soil. Microscopic slides put in these soils and stained with erythrosene revealed comparatively fewer organisms than in Pusa soil. Further

examination was done by determining (i) the hydrogen ion concentration, (ii) the total nitrogen content of the various samples, (iii) the number of organisms by plating, and (iv) per cent. nitrogen (contained in ammonium sulphate) nitrified in Omelianski's solution. The analyses showed that the sands were not altogether barren though less rich in nitrogen and poorer in nitrifying flora than the silt or the normal Pusa soil and the silts very nearly approached the normal Pusa soil.

44. Biochemical transformations attendant on the application of cane molasses to swamp soils.

G. NARASIMHAMURTHY, Bangalore.

When applied in quantities corresponding to about 10 tons per acre, the entire quantity of sugar disappears in the course of the first six days. Carbon dioxide, methane, small quantities of higher hydro-carbons and traces of hydrogen are among the gaseous products formed. Considerable amounts of lactic acid followed by acetic, propionic, and butyric acids are among the chief acid products of decomposition. Ethyl alcohol and acetaldehyde are also produced in small quantities. A quantitative study of the above and related transformations has been carried out and its bearing on crop production with special reference to release of plant nutrients discussed.

45. Utilization of cane molasses for the manufacture of yeast.

S. RAJAGOPAL, Bangalore.

The object of this enquiry was to standardize the conditions for the conversion of molasses into yeasts, pseudo-yeasts or other micro-organisms which can be used as fertilizers. The results so far obtained have shown that in addition to air-supply, the reaction, the minerals in solution and the nature and quantity of added nitrogen are factors determining the yield of dry material. Thus, in a neutral or slightly alkaline medium, with a liberal supply of readily available nitrogen, the fermentation is greatly retarded while the vegetative growth of yeast proceeds unchecked for several hours. Further studies directed towards the complete elimination of fermentation and the conversion of the bulk of the carbonaceous material into the body materials of different organisms are in progress.

46. Molasses as a starter in the composting of waste products of agriculture.

S. RAJAGOPAL and A. V. VARADARAJA IYENGAR,
Bangalore.

The study reported below has been restricted to the waste products of the sugarcane industry, viz. molasses, trash and bagasse, the last to represent highly resistant types of cellulosic matter rather than the actual utilization of the same. The use of molasses as fertilizer has not been neglected hitherto, although both the systems—one of burning it and utilizing the ash and the other applying it directly to the soil—have not found much favour. The possibility of controlling fermentation, by adding molasses to other agricultural wastes, has not so far been attempted, although recently suggestions have been made to this effect. In the present investigation, molasses have been added to a mixture of bagasse and trash and the ratio C/N adjusted by the addition of nitrogen. Samples were periodically examined for dry weight, total and ammoniacal nitrogen, organic matter, and total ash. The results indicate that a compost of good quality can be produced by this method.

47. Changes in microflora and microfauna associated with the decomposition of cane molasses in the swamp soil.

T. R. BHASKARAN, Bangalore.

Quantitative studies of the changes in different forms have shown that there is considerable increase in bacterial numbers immediately after application of molasses to the soil though it is not reflected in plate counts on the commoner count media. Protozoa increase for a time but are subsequently either killed out or get encysted. True yeasts (*Saccharomyces*) were entirely absent while pseudo-yeasts, particularly certain *Torulas* and *Sarcinas*, were seen in small numbers. Fungi and Actinomyces tended to decrease with the progress of the decomposition. The bacteria associated with fermentation are essentially acid producers. Some of them, such as *B. subtilis* and *B. graveolens*, are the commoner forms, while the others are new and have not so far been classified. The physiological activities of the different organisms have been studied and correlated with biochemical transformations observed in the soil.

48. Some of the agricultural and manurial experiments on paddy varieties of Bihar and Orissa.

M. ALAM, Sabour.

A number of agricultural and manurial experiments, such as finding the best age of seedlings at transplantation time and investigating the effect of phosphatic manures, applied in seedbed, on subsequent crop and similar other problems, have been under investigation at the Rice Research Station at Sabour for the last three seasons, and the results of each of them have been statistically analyzed, and those that have been found of some interest from a practical as well as a scientific point of view are described in this paper.

Besides these, a preliminary idea about the fertility gradient of some of the paddy plots has also been obtained and some of the plots have been standardized for future manurial and varietal trials so as to enable us to apply the method of co-variance in working out their statistical significance. These data have also been utilized in finding out the minimum size of individual strips required for manurial and varietal trials on paddy. The conclusions arrived at and the methods employed in conducting the experiments and in working out their statistical significance are fully described in the complete paper.

49. Is manuring of sugarcane a varietal problem?

R. D. REGE and B. H. GHATIKAR, Padegaon.

Periodical analysis of sugarcane varieties has shown that for intelligent manuring, a clear conception of the periodical element-composition of the varieties as well as proportionate amount of various elements that compose them is quite essential.

50. Suggested method of juice analyses for sugarcane plantations devoid of laboratory facilities—Part II.

K. V. GOPALA IYER and T. S. VENKATRAMAN, Coimbatore.

All sugarcane plantations do not possess laboratory facilities for carrying on proper juice analyses of cane samples. Periodic analyses are, however, necessary for efficiently selecting canes to suit each plantation.

Experiments were therefore undertaken to ascertain if, in such cases, the analyses could not be done at some central laboratory on samples

sent to it as railway parcels. The results with medium canes and during the winter months had shown that such analyses could be done without introducing material errors.

Similar experiments carried on with the thick types and during summer months showed that in this case three days railway journey does not materially affect juice composition. The method of packing needs slight alteration from the one adopted for medium canes during the winter months.

51. Effect of soil organic matter and nitrogen on the ripening of sugarcane.

H. N. BATHAM and L. S. NIGAM, Cawnpore.

The same variety of Coimbatore cane, No. 213, was sown on different kinds of soils having different amounts of organic matter and nitrogen. The analysis of the juice of canes and the estimation of organic matter and nitrogen in soils showed a close relation between the amounts of the latter two ingredients of the soils and the ripening of canes.

The conclusions drawn are :—

(i) The poorer the soil is in organic matter, nitrogen and moisture the earlier the cane crop will ripen and less will be its tonnage.

(ii) With the increase of organic matter and nitrogen in the soil the maturation period of the cane crop is prolonged but an increase in tonnage takes place at maturity.

(iii) Certain varieties of canes ripen early and others late. By taking advantage of these characteristics of canes and the amounts of organic matter and nitrogen in the soils the period of the supply of ripe canes to the market can be prolonged from September to May.

52. Manuring of cane in relation to flushing of roots.

K. L. KHANNA, Masheri.

Cane varieties show prominent differences in periodicity of root flushing. Functioning zones at different stages of growth are located in different layers and depths. During dry weather (mid-April to June) they are met with two to three feet below the surface, and in drought-resisting types often below four feet, due primarily to insufficient moisture and consequent absence of stimulus in top layers. In rains most of the new roots are confined to surface layers, often visible above it during very wet weeks. Varieties differ considerably in their response to favourable circumstances. Some throw out flushes with light showers others do it only when heavy showers are received. Manuring when the new white roots have emerged was found to result in better growth and greater dry weights of both shoots and roots at harvest. Details of work, technique employed, and economics of practice to scientific cane culture are discussed.

53. Effect of manures on sugarcane.

P. B. SANYAL, Pusa.

Effect of single manures on the quality of sugarcane juice and *Gur* was studied in 1926-27 and the results published in *Agricultural Journal of India*, Vol. XXIII, Part V. The same experiments were repeated in 1927-28 and in addition the effect of mixed manures was studied the same year. The results for two years' preliminary experiments, 1926-27, 1927-28, on the effect of single and mixed manures on the yield and quality of sugarcane are stated in Part I. The results showed that (i) Nitrogenous manures increased the yield of cane but impaired the quality of its juice

(ii) Superphosphate when added to sulphate of ammonia further increased the yield and improved its quality; (iii) Mustard cake behaved like sulphate of ammonia to which super had been added so far as yield of cane and its quality are concerned; (iv) Mustard cake combined with superphosphate or with superphosphate and sulphate of potash yielded higher than that obtained from mustard cake treatment alone, at the same time the quality of cane did not go down.

In Part II, the effects of combinations (i) Mustard cake; (ii) Mustard cake + sulphate of potash; (iii) Mustard cake + superphosphate; (iv) Mustard cake + sulphate of potash + superphosphate, on sugarcane were studied in 1933-34 in 1/40th acre plots in 4 replications in Fisher's Latin Square and the results showed definitely that addition of (i) superphosphate alone or (ii) superphosphate + sulphate of potash to mustard cake increased the yield of cane as well as total and available sugars significantly. The difference in the increases between (i) and (ii) combination over mustard cake treatment being small, the combination (ii), i.e. superphosphate + mustard cake proved to be economically and statistically significant.

Periodic analyses of sugarcane brought out many interesting observations on the monthly variation of moisture, fibre, sucrose in cane and the quality of its juice from November to March.

54. Removal of some of the injurious salts by ordinary farm crops.

V. A. TAMHANE and B. T. MULWANI, Sakrand-Sind.

All over Sind injurious salts are present in the soil to a greater or less extent. Nearly 30% of the area at the Agricultural Research Station, Sakrand, was found to contain injurious salts in varying quantities.

It was therefore thought necessary to tackle the problem of reclamation of such kalar or salt lands in a number of ways. Over and above the chemical and mechanical methods of reclamation it was found essential to study the amount of kalar or salts removed by some of the most commonly grown farm crops. From plant analyses of cotton (*Gossypium*), Jowar (*Andropogon sorghum*), Wheat (*Triticum vulgare*), Bajri (*Pennisetum typhoides*), and Berseem (*Trifolium alexandrinum*), conducted at the Agricultural Research Station, Sakrand, it was found that the Bajri plant comparatively removes the greatest quantities of kalar or salts from the soil whereas the wheat plant removes the least. The order of merit so far as this power of taking up salts is concerned was found to be as follows:—(1) Bajri (*Pennisetum typhoides*); (2) Berseem (*Trifolium alexandrinum*); (3) Cotton (*Gossypium*); (4) Jowar (*Andropogon sorghum*); and (5) Wheat (*Triticum vulgare*).

PLANT PHYSIOLOGY.

55. Rôle of silica in the nutrition of the rice plant.

A. SREENIVASAN, Bangalore.

Rice plant has been grown under dry as well as swamp soil conditions in pots receiving different manurial treatments and a preliminary investigation is made of the intake of silica by the plant at various stages of growth. An attempt to follow the corresponding changes in soluble silicate content in the soil-system is made difficult on account of the fact that the soil colloids react with the soluble silicate resulting in a part of the latter being converted into non-available forms. The nature of reactions leading to the retention of soluble silica by soil minerals has been elucidated and the conditions for determining the 'availability of silica' in such cases both by chemical and seedlings extraction methods

are described. Further work with regard to (a) the possible relationship between silicate fixation and phosphorus resorption in soils and (b) the extent of dissolution of silica in swampy and dry soils by green manure decomposition is under investigation.

56. Soaking seed canes—its effect on germination and growth II.

K. L. KHANNA, Masheri.

Work reported herein is in elaboration and confirmation of the results submitted at the 20th Session of the Indian Science Congress in 1933. Experiments were laid out in a system of randomised blocks with a fairly large number of replications and results interpreted in the light of Fisher's analysis of variance. Statistically significant differences were obtained in favour of the treatment.

57. Respiration studies on sugarcane *in situ*—Pt. I.

K. L. KHANNA and P. C. RAHEJA, Masheri.

Respiration studies on eight prominent varieties of sugarcane were conducted during the last season. Respiration rate was low in the morning, rose with rise in temperature till the latter became supra-optimal about afternoon, when this rate fell considerably. With the approach of favourable temperatures late in the evening, however, plants tended to regain their normal function. In the beginning of hot weather the 2-hourly fluctuations in the respiratory activity during the day were very wide. With the passage of time and possibly through adaptation these variations became less marked later. During the course of day and night through the season some varieties exhibited higher response to rise and fall of temperature than the others. The varietal position in descending order with regard to response which showed a certain amount of relationship with the chlorophyll concentration in the leaves was as follows:—Cos. 213, 299, 210, 356, 326, 331, 214, 313.

The advance of hot weather also saw varieties cutting down their metabolic activity in the order of their decreasing drought resistance.

58. Developmental studies in rice (*Oryza sativa*).

K. RAMIAH, Coimbatore.

The importance of developmental studies in determining yield attributes is well recognized. The final yields of a number of specially laid cultural and manurial experiments in rice were analyzed in terms of the chief developmental phase, tillering. The effect on tillering of such factors like age of seedling, spacing, application of manures either to the seed-bed or to the transplant field, time of applying a fertiliser to the transplant field, etc., were determined.

The main conclusions arrived at as a result of these studies are:—

- (i) Tillering is a varietal character, and the percentage of functional tillers to the total number of tillers produced per plant varies from 50 to 80.
- (ii) Early tillering is an index of vigour and has a direct relation to final yield.
- (iii) There is a 'critical period' of tillering which varies with varieties according to their duration, and tillers produced beyond the period bear no relation to yield.
- (iv) Spacing influences tillering more than even manuring in the early stages.

- (v) There is an optimum spacing, different for different varieties, beyond which the increase in the number of functional tillers does not compensate for the reduction in the number of plants per unit area.
- (vi) Tillering and final yields are influenced more by the application of manures to the transplant field rather than to the seed-bed.
- (vii) A fertiliser like ammonium sulphate encourages rapid initial tillering when applied early, but later applications improve the size of the ear formed, probably a more potent factor in enhancing yield.

59. Studies on germination of paddy seeds.

M. ALAM and A. B. SARAN, Sabour.

Suitability of depths to which paddy seeds could be put in the soil for germination.—Germination tests were carried out at different depths ranging from .5 to 8 inches. The seeds germinated uniformly at all the depths, but the percentage of emergence of seedlings from the soil varied inversely to the depth. It has also been found that, at higher depths, the plumular sheath is membranous and short; while at lower, it grows taller and becomes thick, stiff, and pointed.

Effect of temperature on germination percentage of various classes of paddies.—Germination tests of seeds from different classes (early, medium, and late) of Aman or Winter paddy, having the same maturity, were carried out at five different temperatures, namely 18-19°C., 25°C., 30°C., and 40-42°C. It is found that germination percentage increases with an increase in temperature up to 30°C. after which (e.g. 40-42°C.) a deteriorating effect is evident in all samples studied. Similar tests were also carried out for Dalua or Summer paddy varieties and it has been found that these varieties are more adaptable to lower temperature than the Aman varieties, especially the medium and late ones. The temperature for optimum germination was, however, found to be the same for all classes of paddies.

Influence of soil condition (acid or alkaline) on germination percentage of paddy.—Germination tests of different classes of paddy were carried out in various concentrations of common salt varying from 0.5 to 4%, and it has been found that germination is practically normal for all varieties in 0.5% salt solution, but with higher doses different varieties behave differently showing a gradual fall in germination percentage up to 2% concentration, above which there is no germination at all.

The effect of various pH values on the germination percentage of paddy seeds was also tried and it is found that slightly acidic medium has a marked effect on the vigour of germination. Seedlings raised from such treatments produced distinctly superior plants.

60. Physiological studies on salt tolerance of paddy.

M. ALAM and A. B. SARAN, Sabour.

Root development.—The development of roots of three-week old paddy seedlings, when placed in different concentrations of common salt, has been studied in detail, and it is found that root development is practically normal in cultures with a salt concentration below .5%, but in higher concentrations a deteriorating effect is noticeable. Seedlings of younger age (5 and 15 days), however, showed normal root development only up to a concentration of .3%, whereas in .5% root development was rather scanty.

Antagonism of the lethal effect of common salt by calcium.—Experiments were first conducted to find out the lethal dose of common salt for paddy and then the dose and strength of calcium salt required to antagonize

the toxic action produced by higher salt concentrations was investigated and it has been found that 3 c.c. of 1% calcium nitrate solution could successfully antagonize the lethal action of 1.3% common salt in a 500 c.c. culture solution.

Gradual education of paddy plants to tolerate salinity.—The problem of gradually inducing the paddy plants to tolerate salinity, by first growing them under low saline conditions for one generation and then growing the progeny from these in soils of higher salinity in the next, is also under investigation. The results so far obtained are quite interesting and indicate the facultative nature of rice plant which may enable us to solve the problem of growing paddy in saline areas by first treating the seeds of certain selected strains in lower percentage of salinity and then growing them in soils of higher salinity.

Pretreatment of seeds with small doses of common salt solution.—Seeds were soaked in salt solutions varying in concentrations from .1 to .0001%, and also in pure distilled water, for 24 hours. After the soaking, they were dried in air and their germination capacity was tested in 1.5% salt solution. It was found that by this treatment there was definite increase in the germination percentage over that of the control, but this increase varied with different treatments.

61. The dormancy and viability of seed of various classes of paddies.

M. ALAM and A. B. SARAN, Sabour.

Germination tests of seeds from early, medium, and late paddy varieties were carried out at regular intervals (commencing from the date of harvesting) at a controlled temperature of 30°C. It has been found that the germination percentage increases as the time advances from the date of harvesting till an optimum is reached, which lasts for about 8 months in all the varieties tested and then ensues a decline. This loss in viability starts rather early in the early and medium than in the later varieties. Certain chemicals like copper sulphate, and chilling of seeds were tried to revive the lost viability. The results obtained are interesting and have been dealt with, in detail, in the full paper.

62. Experiments on the germination of cotton seed.

B. B. MULCHANDANI, Parbhani-Deccan.

Three experiments were conducted with a view to find out the optimum standard of—(i) Soaking period, (ii) number of seeds, and (iii) depth necessary to get best germination of cotton seed. Sowing was done under true field conditions at Government Main Farm, Parbhani (Deccan) in H.E.H. the Nizam's Dominions. Two widely different species: *G. indicum* (Gaorani 12) and *G. hirsutum* (Parbhani American 1) were used for the purpose. The former has got small seed each weighing about .0550 grammes with a fuzz amounting to about 3.6%, while the latter's corresponding figures are .0995 and 13.6%. In each of the three experiments there were six different treatments. In experiment I, *G. indicum* had 16, 11, 6½, 3½, 1½, and 0 hours, and *G. hirsutum* has 21, 16, 11, 6½, 3, and 0 hours soaking. Both the varieties in experiment II had 1, 2, 3, 4, 5, and 6 seeds per dibble, and in experiment III, 1", 1½", 2", 2½", 3½", and 5" depth. There were six replications and the plots were arranged in a Latin Square. The sowings of *G. indicum* and *G. hirsutum* strains were done on 24th July, 1934 and 25th July, 1934 respectively. The temperature during the germination period ranged from 72°F. to 89°F. and there was rainfall almost every day. The condition of the climate compared fairly well with the actual period of sowing in June-July.

The following conclusions were drawn :—(a) longer period of soaking gave quicker germination. In spite of too much rain after sowing *G. indicum* with 16 hours' and *G. hirsutum* with 21 hours' soaking the germinating power of the seed was not lessened. Unsoaked seed of *G. indicum* germinated more quickly than that of *G. hirsutum* but the reverse was the case with the seed soaked for 16 hours. (b) Greater number of seeds per dibble gave greater percentage of germinated dibles but the percentage of seeds that germinated, decreased with the higher number of seeds and the germination was as well delayed. Four seeds per dibble seemed to be sufficient. (c) $1\frac{1}{2}$ " and 2" depth were found to be optimum for *G. indicum* and *G. hirsutum* strains respectively. The greater depths gave less germination which was slowed as well. The shallower depths had probably greater chances of being attacked by insects and hence less germination in spite of sufficient moisture.

63. A quantitative method for the study of the root system of sugarcane under varying physiological treatments.

R. D. REGE and P. V. WAGLE, Padegaon.

During the course of physiological investigations, quantitative methods of root study recommended by various workers were not found sufficiently accurate to differentiate the effect of different treatments. A new method has been evolved and it is observed to give very promising results.

64. Some observations on the movements of *Basella cordifolia*.

B. N. SARKAR, Patna.

The various growth curvatures exhibited by climbing plants in taking hold of external supports have been invariably ascribed, as far as the writer is aware, to the stimulus of contact between the support and the climbing organ of the plant. Preliminary observations made on *Basella cordifolia*, however, suggest that an incipient perception of the support precedes the actual contact inducing marked and unmistakable curvatures in the plant towards the perceived support even when the latter is at a considerable distance from the plant. The phenomenon in question may be a manifestation of one of the stimuli to which plants are known to be susceptible, but the possibility that it may be due to some stimulus hitherto not associated with plant response is not excluded. Further investigations are proceeding.

A brief description of the plant is given.

65. Influences dominating cotton yields in monsoon areas—I.

KUBER SINGH and YESHWANT D. WAD, Indore.

Selection has increased acre-yields up to 20 per cent. in selected strains of Malvi cotton, but much wider variation exists in field crops. Any approach to the peak yields found there would mean a substantial improvement in cotton production. The location of the factors responsible for such fluctuations shows the way to profitable adjustments. Irrespective of varieties of cotton in field tests in 1932 when sown in the same early season as crops in highly productive areas yielded equally well. In 1933, however, the advantages of early sowing were almost counterbalanced by other factors. A closer analysis of the experimental data showed that soil conditions conducive to intense nitrification were always associated with high yields. Even a slight advantage in this respect gave significantly higher yields for the more sensitive varieties. Higher yields were obtained with wider spacings, also a better plant-performance, associated with greater root development. The importance

of total intake of nutrients rather than their concentration was indicated. Localization of the elaboration of absorbed nutrients by topping during the early stages of plant growth produced higher yields, without a change of soil nutrient level. The most efficient crop is early and has the highest ratio of seed cotton to plant weight. Crop adjustment on this basis is advocated.

GENETICS AND PLANT BREEDING.

66. Inheritance of some anatomical characters responsible for lodging in barley.

R. D. BOSE, M. P. BHATNAGAR, and M. A. AZIZ, Pusa.

A cross between two Pusa barleys, type 21 \times type 1, was studied genetically for the inheritance of some anatomical characters in relation to lodging. Type 21 possesses strong straw and type 1 has rather weak straw. No previous work of this nature appears to have been published on the nature of inheritance of internal anatomical characters responsible for the lodging of cereals.

The problem of lodging is too complex to depend on any one single factor, but that anatomical structures do play a very important rôle in lodging is a fact that cannot be contested. The present studies show that the development of these mechanical tissues, like any other external character, is controlled by Mendelian factors.

Material was collected from parental lines and from F_2 and F_3 populations after internodal growth had completely ceased, but before the grain was actually ripe. A piece about 3 cm. in length was cut at the third internode from the top of the main culm of each plant and preserved for a couple of months in formalin alcohol. Free hand cross-sections were taken of each and stained with safranin.

Four anatomical phenotypes were recognized according to the arrangement and position of the peripheral sclerenchyma. Thus—

<i>Phenotype.</i>	<i>Arrangement and position of sclerenchyma.</i>
Like type 1 Very close to the periphery and poorly developed.
Inter—A Generally close to the periphery and well developed.
Inter—B Mostly away from the periphery and connected at places by irregularly placed sub-epidermal girders; mechanical tissue well developed.
Like type 21 Away from the periphery and connected to it at regular intervals by well-developed sub-epidermal girders; mechanical tissue very well developed.

Two genetic factors appear to be responsible for the inheritance of this character. If *A* represents a dominant factor for susceptibility to lodging and *B* a supplementary factor which is less potent than *A* in effect, but which in the presence of this factor induces complete lodging, the recessive allelomorphs *a* and *b* condition resistance to lodging. Then barley type 1 may be said to have the constitution *AABB*, while type 21 has *aabb*. Inter-A will then have *AAbb* and Inter-B will have *aaBB*. The F_2 segregates into 9 *AB* : 3 *Ab* : 3 *aB* : 1 *ab*.

The following internal characters showed transgressive segregation and all of them showed definite association with the nature of the mechanical tissue:—(i) Width of sclerenchymatous tissue; (ii) Thickness of the sclerenchymatous cell-wall; (iii) Diameter of the long axis of the vascular bundles; and (iv) Diameter of the short axis of the vascular bundles.

The undermentioned characters showed definite positive correlation between themselves :—(i) Width and thickness of sclerenchymatous tissue ; (ii) Long and short diameter of the vascular bundles ; (iii) Thickness of the sclerenchyma and the long diameter of the vascular bundles ; (iv) Thickness of the sclerenchyma and the short diameter of the vascular bundles.

No correlation was found to exist between the anatomical phenotypes and (i) fertility of the ear-head ; (ii) length of ear-head ; (iii) tillering capacity of plants ; and (iv) Maturity of the plants.

67. Inheritance of some characters in the barley ear-head.

R. D. BOSE, M. A. AZIZ, and M. P. BHATNAGAR.

In a cross between Pusa type 21 and Pusa type 1 which are 6-rowed and 2-rowed barleys respectively, single factors have been found to determine the following characters :—

- (i) Fertility of the lateral florets—2-rowed : Intermediate : 6-rowed as 1 : 2 : 1.
- (ii) Awns on the inner glumes of the lateral florets—1 Nil : 2 Intermediate : 1 Full.
- (iii) Nature of outer glumes—3 Narrows : 1 Broad.

The inheritance in items (i) and (ii) seems to depend upon the interaction of the same genetic factors and there is complete linkage between (a) 2-rowed fertility and development of no awns on the lateral florets, (b) Intermediate fertility and development of pointed or tipped awns on the lateral florets, and (c) 6-rowed fertility and development of fully developed awns on the lateral florets.

The repulsion phase of linkage is exhibited when the relationship between fertility and the nature of outer glumes or between the development of awns on the inner glumes of the lateral florets and the nature of outer glumes are studied. The cross-over value in both cases works out to 23.15 per cent.

There is no linkage between fertility or nature of outer glumes and (a) maturity as measured by the number of days taken by individual plants to head out, (b) length of ear-heads in cm., and (c) internode length as represented by the length of 10 internodes in cm.

A number of other characters have also been studied in this cross and the mode of their inheritance will be described in a subsequent publication.

68. A genetical analysis of *Cicer arietinum* (gram).

M. ALAM, Sabour.

This work was originally started with a single cross between a *Kabuli* and a *Desi* gram type. The results obtained from this cross, which have already been submitted elsewhere for publication, were so interesting, but at the same time rather complex, that in subsequent years a number of other crosses between 6 or 7 different gram types, all belonging to the pure lines isolated in the Botanical Section, Pusa, were taken up and an attempt to work out a complete genetical analysis of this species, for which there was no published record till then, was made.

A fairly complete analysis of the Mendelian factors that are involved in the appearance of different vegetative and floral characters has been made. Besides this, the inheritance of seed-color, seed-shape and surface has also been studied in detail and the basis of their inheritance worked out. The seed-color alone is found to be based on the presence and absence of, at least 4 different factors, some of which are found to be linked with

the factors determining seed-shape and surface. There also exists a very strong correlation or linkage between flower color and seed color, which has been found to break only in some of the crosses, whereas in others the correlation is perfect. An interesting relationship between some of the qualitative and quantitative characters has also been established, but the detailed results of quantitative characters will form the subject matter of a separate paper to be published at a later date.

69. Studies in the pulses of Bihar and Orissa—I (Rahar).

T. C. N. SINGH, Sabour.

Six types of Sabour *rahars* hitherto undescribed, have been fully dealt with botanically. Out of these, two belong to the spreading group and the rest to the erect. The types are separable chiefly on the characters of their flower, fruit, and seed. Complete descriptions are given in the fuller paper. Grains from each type would be exhibited in the sectional meeting.

70. Studies in the oil-seeds of Bihar and Orissa—I (Mustard).

T. C. N. SINGH, Sabour.

The author gives a botanical description of five of the Sabour mustards. Out of these, one is an early type and the rest are late. The latter are easily recognizable on characters based on their inflorescence, fruit, and seed. Details are recorded in the fuller paper. Grains from each type will be exhibited in the sectional meeting.

71. Inheritance of inner glume colour in rice.

S. K. MITRA and P. M. GANGULI, Jorhat.

The factors determining the inheritance of inner glume colour in rice have been studied in three crosses. The factors C and L are responsible for the production of blackish green and light brown colours respectively. The presence of both will make the colour green while their total absence will make it brown in the ratio of 9 green : 3 blackish gr. : 3 light brown : 1 brown.

The black colour of the mature inner glume is the result of the combined effects of the factors B_1 and B_2 while Y alone or in combination with either B_1 or B_2 will make the colour yellow. The blackish brown colour will appear in the absence of Y. B_1 and B_2 are together dominant over Y while Y is dominant over either B_1 or B_2 . The F_2 segregation is in the ratio of 36 black : 21 yellow : 7 blackish brown. The F_3 behaviour has also conformed with the expected segregations.

72. Isolation of pure lines of the paddy varieties of South Bihar.

M. ALAM and A. R. AKHTAR, Sabour.

The unusually large number of paddy varieties that exist in nature made it necessary to take up the work of isolation of pure lines of this crop in parts and the material collected by the senior author in 1929-30, before the establishment of the Rice Research Station, has enabled us to complete this work. Nearly 250 distinct strains have been isolated and classified not only on the basis of grain and spikelet characters, which have generally been taken into consideration by most of the previous

workers, but also on the basis of important vegetative and agricultural characters, such as time of maturity, lodging habit etc., that are considered to be of practical importance. The general scheme of classification and the basis on which it has been adopted is indicated in the text of the paper and is discussed in some detail. The more characteristic features of some of the pure lines that differ remarkably from one another and those that are found to be of some economic importance are described separately at the end of the paper.

73. Spikelet bearing bristles in *Pennisetum typhoides* Stapf and Hubbard—the pearl millet.

G. N. RANGASWAMI AYYANGAR, V. GOMATHINAYAGAM PILLAI,
and P. V. HARIHARAN, Coimbatore.

Spikelet bearing bristles have been met with and their bearing on the nature of the bristle is discussed.

74. Serial experiments.

R. D. BOSE, Pusa.

The object of most varietal or manurial trials is to determine which particular treatment is the best for the particular conditions of the locality or climate under which the experiment has been conducted, and generally on the results of such trials, recommendations are based regarding improved varieties, manurial or cultural treatments. It is, however, not very safe to base recommendations on the results obtained from a single experiment conducted for but a single season as it is quite possible that the same treatment may respond differentially when subjected to varying soil and seasonal conditions. This fact is illustrated by the result of yield trials conducted with some Pusa oats simultaneously at Pusa and Karnal for three consecutive seasons and the method of combining and calculating such results in the form of a serial experiment is described in detail.

75. *Paspalum dilatatum* Poir—a promising exotic grass for Assam.

D. M. SENGUPTA, Jorhat.

Seeds of *Paspalum dilatatum*, a hardy perennial tussock grass, were brought from Australia in the year 1928 and were successfully grown at the Jorhat farm. Repeated trials with this grass in several agricultural experimental stations of the province have proved it to be a good pasture land grass.

Though under cultivation it is not equal in yield to Guinea or Elephant grass, its real value lies in its use as a pasture land grass. It has good nutritive value and is always liked by cattle. It may also be used as a soil binder and as an agent to check undesirable weeds and grasses in a pasture-land.

76. Seeding in potatoes in Bihar.

K. L. KHANNA, Masheri.

Successful attempts to obtain viable seeds in potatoes (*Solanum tuberosum* var. Phalwa) were made under conditions of controlled temperature and atmospheric humidities. Observations proved variety 'surkha' to be female sterile. Possibilities of hybridization work with foreign stock are discussed.

PLANT PATHOLOGY.

77. Observations on the root-rot of cotton in Gujarat.

V. N. LIKHITE.

Subsidized by a grant from the Indian Central Cotton Committee, research was begun in February 1932, when the crop of the season, 1931-32 was over. Observations are, therefore, for the seasons 1932-33 and 1933-34. Important primary observations, on the Baroda Agricultural Experimental Station where a May-sown crop was continuously taken for the last several years, made by the writer since his arrival in 1929 were that the May-sown crop suffered heavily—almost to 90% or over as compared to the monsoon-sown one—which suffered only to an extent of 33% or near about. This led to the starting of a breeding section immediately, as susceptible varieties could be easily eliminated under May-sown conditions. In the season of 1932-33 certain areas on the station were allotted to these experiments. Soil history as to the occurrence of rot was taken that year by drilling cotton under May-sown conditions in the area. Principally four organisms were constantly isolated from affected roots—(1) *Microphomina* sp. (*Rhizoctonia bataticola*); (2) *Fusarium vasinfectum*; (3) *Cephalosporium* sp.; (4) *Cephalobus* sp. (?)—a species of Nematodes. Of these *Fusarium* from Baroda is found to be quite harmless under any conditions. *Rhizoctonia* has yielded some evidence in favour of parasitism. Nothing certain for the present can be said about the remaining two organisms.

Experiments are arranged now adapting the May-sown conditions for which temperature observations of soil, etc. have been taken. pH of the filtra of these cultures shows acidic tendency for *Fusarium* and alkaline for *Rhizoctonia* and Nematodes. The soil is light sandy loam and gives alkaline reaction. This is more in favour of the parasitism from *Rhizoctonia* and Nematodes. Weekly incidence of rot is taken. Rot may appear after 15 days or so from the date of sowing and may continue to end of January. The season is over by end of March, but the crop generally stands till monsoon begins and it is only after the first showers when the soils becomes loose that these stalks are removed by cultivators and another sowing made. Experiments are arranged on randomized block system to see the effects of disinfectants and manures on the control of rot. Work is going on to find out resistant or immune strains and for this seed selection from different pickings, vernalization and other treatments are also tried to test the favourable character. Spacing and ridging is also tried to find out if these methods will be in any way useful to check the disease. Weeds from affected cotton fields are collected and some are found to suffer from the malady. Root-System is studied.

78. Varietal resistance in Pusa barleys to *Helminthosporium sativum* P. K. and B. and *H. teres* Sacc.

M. MITRA and R. D. BOSE, Pusa.

Helminthosporium sativum causes 'foot—and root-rot' of barley seedlings and 'spot blotch' of barley leaves and does a good deal of damage to the crop. The percentage of seed germination is reduced, the affected plants are stunted, the leaves are discoloured followed by the shrivelling up of the grain and a reduction in the yield. The fungus is soil and seed borne and persists in the debris of affected plants. Wheat and certain other grasses are also affected by it.

Helminthosporium teres causes the 'net blotch' in barley and occurs only on certain introduced types.

Investigations carried on at Pusa for the past four years have shown that environmental factors play a great part in bringing about the disease due to these two organisms and that the severity of the disease varies

from field to field and even in the different parts of the same field. Varietal difference in the degree of attack on the different types was also noticed. Early varieties seemed to suffer less. The degree of attack varies from season to season.

The percentage of leaf area destroyed in the various varieties was determined and in both the introduced and the Pusa varieties there are types which show considerable resistance to the disease and promising selections have been made.

Fungicidal dusts and liquids have been used to reduce losses but none have so far been found to be quite effective in completely controlling the disease. While the seedling disease has been controlled to some extent, it has not been possible to check secondary infection at healing time from the infective material already in the soil or from other hosts.

The study of varietal resistance is therefore of great importance for that seems to be the only effective method of fighting this disease. Work in selecting types which combine resistance to these fungi and desirable agronomic characters has made considerable progress at Pusa.

79. The parasitism of *Sclerotium oryzae* Catt.

B. B. MUNDKUR, Pusa.

Discrepancies in the symptoms of the sclerotial disease of rice (*Oryza sativa* L.) as described by different investigators are pointed out. Cultures assembled from various geographic locations fell into four groups and this paper deals with two of them. One *Sclerotium* had the ability to change the colour of certain substrates, coloured hyphae, smooth and small sclerotia and was identified as *Sclerotium oryzae* Catt. The cultures produced conidia of *Helminthosporium sigmoideum* Cava. The other considered as non-chromogenic strain on *S. oryzae* by Bertus had a hyaline mycelium, was unable to change the colour of substrates, possessed larger sclerotia with a rough surface and was identified as *Rhizoctonia microsclerotia* Matz.

Disease was not produced in pots and fields heavily infected with sclerotia. The fungus occurs in the rice fields and sclerotia can be seen infesting the sheaths and culms of healthy plants. Some plants with excessive tillers had sclerotial infestation while a large number did not. Sterility could not be correlated with the presence of these fungi. Conclusion is drawn that under Indian conditions, *S. oryzae* is unable to produce any disease in rice.

80. Life history of gram blight *Ascochyta rabiei* (Pass) Lab= *Phyllosticta rabiei* (Pass) Trotter and measures for its control.

J. C. LUTHRA, ABDUS SATTAR, and K. S. BEDI, Lyallpur.

Next to wheat, gram occupies the largest area of 3½ million acres in the Punjab. In the North-West part of the province it has been seriously affected by the blight disease and on an average 50% of the crop has been totally destroyed for many years. The disease is caused by the fungus *Ascochyta rabiei*=*Phyllosticta rabiei*. Its prominent symptoms are:—Dark brown lesions bearing Pycnidia in the form of small dots are formed on the leaves, leaf stalks, and pods. The disease appears in February and if the weather is moist and there are frequent showers of rain accompanied by winds the disease progresses fast and during the flowering and fruiting period in March-April it becomes very severe and the affected crop is altogether destroyed.

Description of the Fungus. Hyphae are hyaline or light brown and septate. The pycnidium is spherical or pear shaped with an opening

(ostiole) at the top. In the pycnidial chamber there are numerous spores borne on small conidiophores. On being moistened the pycnidia burst open and numerous spores are thrown out. The spores are mostly unicellular.

Modes of perennation.—The disease is carried over from one season to the other by the following two methods:—(1) by affected seed; (2) by the diseased plant debris which remain lying on the surface of the soil after the crop is harvested. After the disease has appeared in the crop either by using infected seed or by the transfer of infection from diseased plant material already present in the field there is considerable secondary infection from the primary sources. Under favourable conditions the disease is disseminated very rapidly.

Control measures.—Experiments carried out in the last three years have confirmed that the disease can be effectively checked by adopting the following measures:—(a) by sowing healthy seed; (b) by destroying all diseased plant material after harvest; (c) if the plant diseased material is buried in the soil which is somewhat moist within a month the fungus is altogether killed.

81. A new blight disease of gram.

M. MITRA, Pusa.

A blight disease of gram caused by a species of *Mystrosporium* hitherto unknown has been noticed at Pusa. The fungus forms roundish spots, 0.5 to 4 mm. in diameter of yellowish brown colour with a pale reddish ring. In severe cases the leaflets fall off and the disease spreads to petiole and stem. The fructification appears on the central dead portion of the spot giving it a blackish appearance.

Conidiophores are dark brown, the tint deepens towards the tip which is flattened. They are multicellular, 30–50 μ in diameter. Conidia are borne singly, are sub-spherical, ovate or oblong, 2 to 7 celled, muriform, dark brown, 13–33 \times 9–26 μ in diameter, the average being 22 \times 19 μ .

The fungus grows best between 18–25°C., with an optimum at 22°. It tolerates a high range of H-ion concentration, the growth is best at 7.8 pH.

The disease becomes bad after rain during winter. It is seed borne and several fungicides were tried to control it. Formalin 0.5 per cent. checks the disease. Secondary infection is reduced by two or three applications of 1 per cent. Bordeaux mixture.

Several types of gram are immune, others are slightly susceptible while type 68 is highly susceptible. By breeding resistance varieties the disease can easily be controlled.

82. A new disease of sugarcane.

S. V. DESAI, Pusa.

A new disease of sugarcane was observed at Museri Sugarcane Research Station. The symptoms of the disease were wilting of the canes and rotting of the plant from top downwards with a strong smell of fermenting debris. The disease appeared during monsoon, the affected plants rotted very quickly and the stem became a mass of semi-solid stinking pulp. Hence it is named 'Stinking rot'. The causative organisms were isolated and studied. Two types of Bacteria were found in the affected tissues. One was pathogenic and the other saprophytic, but the mixed cultures were found to be much more effective in bringing about the disease by artificial inoculation.

Biochemical and cultural reactions of the pathogenic organisms were allied to organisms of the *Pyocyanus* group but differed from *Phy. Xanthochlorum*, *B. Aptatum* and *B. Marginale*, which represent the allied pathogenic types of this group.

The organisms were non-pathogenic to potato, beans, tomato, tobacco, and other plants tried. The pathogenicity was only confined to sugarcane. The infection in plants is supposed to be through top shoot borer holes. The 'dead heart' formed a suitable medium for mass development which initiated vigorous rotting, some plants being killed within a fortnight.

83. Physical properties of sugarcane mosaic virus.

S. A. RAFAY, Pusa.

Fresh sugarcane leaves affected with mosaic were ground up with equal weight of water and extracted through a cheese-cloth. The extracted juice was used as standard. After treatment it was inoculated to healthy plants to test the infectivity of the virus.

(i) CuSO_4 , 1 in 1,500; HgCl_2 , 1 in 1,000; HCl , 1 in 1,000; HNO_3 , 1 in 800; NaCl , 1 in 25; H_2O_2 , 1 in 25 and Formalin, 1 in 50 inactivated the virus. Zn powder and MnO_2 , 1 in 20, did not retard the activity.

By comparison with highly resistant viruses like mosaic virus of tobacco, aucuba mosaic of tomato and comparatively less resistant types like crinkle mosaic and rugose of tomato this was found to be the most sensitive and least resistant.

(ii) Dilutions beyond 1 to 10 were non-infective. Thus dilution readily inactivated the virus.

(iii) An hour after extraction the juice was inactivated.

(iv) The juice was repeatedly filtered through the same filter funnel till the filtrate was clear brown liquid. The residue left on the filter paper was infective while the brown filtrate was non-infective.

84. Recovery of chlorophyll in certain varieties of mosaic-infected canes.

S. A. RAFAY, Pusa.

The relative amount of chlorophyll in leaves of healthy and mosaic plants of Co. 213 and Saretha (a local variety) was studied at different times of the year. Under identical conditions chlorophyll was extracted in warm 85% alcohol from equal areas punched from healthy and mosaic leaves of same growth and age and compared in a Dubosque Colorimeter. The relative percentage of chlorophyll in mosaic as compared to the healthy leaves was least during the monsoon in both the varieties after which it gradually tended towards normality. This showed that the plants recovered from the effect of mosaic after the monsoon.

Leaf to leaf variation in the chlorophyll content of mosaic and healthy leaves followed the same course. Topmost leaves and the older ones below were very poor in chlorophyll, the functioning leaves being 2nd from the top to 9th. Fourth and fifth leaves had the highest amounts of chlorophyll. The difference in the percentage in mosaic as compared to healthy in different leaves was most marked in fourth leaf in Co. 213 and third leaf in Saretha.

85. The antigenic properties of the sugarcane mosaic virus.

S. V. DESAI, Pusa.

The rabbits were immunized by inoculating with increasing doses of Chamberland Candle filtrates of mosaic and healthy leaf juices intravenously. Anti-mosaic and anti-healthy juice sera were used for precipitation and other serological tests. Anti-mosaic serum inactivated the

mosaic leaf juice while anti-healthy serum had no effect as was proved by inoculating ten plants with each of the sera-mosaic leaf juice mixture. All plants inoculated with anti-mosaic serum and mosaic leaf juice mixture remained quite healthy while the similar mixture with anti-healthy serum was infective to the plants inoculated. Precipitation tests with diluted sera and leaf juices showed that the anti-mosaic serum gave a positive reaction with mosaic leaf juice and negative against healthy leaf juice. Anti-healthy, however, gave positive reaction for both leaf juices, though the reaction was faint in both the cases. This may be due to the antigenic properties of the plant protein present in the leaf juice used for immunizing the rabbits. The plant juices used as antigen did not give Millon's, Biuret, and other protein reactions. The nitrogen in the juices was found to be .01 per cent.

86. Plant vitality—a factor in nutrition and disease resistance.

K. L. KHANNA, Masheri.

Successful injection methods into plant body were developed in connection with the study of yellowing in canes in 1932 and these methods have later found wider applicability in the study of plant vitality in terms of lethal doses of poisons. Various manured and otherwise cultured plants, some very well grown, others stunted and visibly unhealthy were subjected to these tests. They have shown that doses of poisons that can easily be tolerated by healthy and well grown plants prove fatal to plants poorly grown or suffering from disease. Plants fertilized with nitrogenous manures showed lower vitality than those manured with potash. Weaking plants showed poorer response to favourable set of conditions as compared to others. Growth stimulation could also be brought about through feeding artificially and vitality raised. Advisability of administering tonics when plant vitality is very low is seriously to be questioned and the economics of application of manure to stunted crops reconsidered in the light of this knowledge. Experiments on the possibility of introducing disease immunity through enhanced vitality were attempted and results are being awaited with interest.

ENTOMOLOGY.

87. Chillies cultivation in the Periyakulam area of Madura district with special reference to leaf-curl caused by thrips.

T. V. RAMAKRISHNA AYYAR and M. S. SUBBIAH,
Coimbatore.

The occurrence of leaf-curl disease on the chillies crop grown on a fairly extensive scale in the Periyakulam taluq having become very appreciable and serious during the past few years, an investigation was made of the disease with the idea of finding out measures to control the same. In this paper are included a brief summary of the results of the investigation of the disease and its causative agent and the trials made to combat the disease. The chief agent involved in this trouble is a thrips (*Scirtothrips dorsalis* H.) which sucks up the plant sap from the tender tissues of the plant in all stages of growth: in bad infestations all the leaves of the plant get curled up, the plants become stunted and gradually fade, thus causing appreciable loss in out-turn. In this study the various factors influencing the incidence of the pest in relation to the local conditions are briefly discussed and the practical methods adopted to control the pest are described and finally the economic aspect of the whole problem is presented.

88. The cotton leaf-roller (*Sylepta derogata* Febr.) in the Punjab.

M. AFZAL HUSAIN, Lyallpur.

During recent years the cotton leaf-roller has assumed great importance in the Punjab as a serious pest of the American cottons. Last year it defoliated a very large area, but luckily the worst attack came at a stage when the boll formation had reached its maximum, and much damage was not done.

The life-history and the seasonal-history of the pest have been studied and various control measures tried. It is interesting to note that the pest appears in cotton fields on the edge of the forest areas. In certain cases volunteer cotton plants in the forest act as the centre of infestation.

Among the natural enemies the birds are of great importance, particularly the Himalayan Starling, Franklin's Crested Lark, the Indian Pupil, and the Indian Hoopoe.

89. A new disease of Cardamom (*Elettaria cardamomum*) apparently due to insect damage in S. India.

T. V. RAMAKRISHNA AYYAR and M. S. KYLASAM,
Coimbatore.

As far as the writers are aware very little is on record regarding the insect pests of the cardamom crop in India. Recently a report was received from an estate in the Annamalai hills. South India, of a new disease to the growing crop. This was investigated and was found to be due to an insect pest (thrips) not recorded before. This paper includes a brief report of the study made of the pest and the damage it causes to this valuable crop.

90. The sugarcane top-borer (*Scirpophaga nivella*) in the Punjab.

M. AFZAL HUSAIN, Lyallpur.

The development of sugar industry in the Punjab has led to certain changes in agricultural practices which are creating fresh entomological problems. For the success of a sugar factory a long crushing season is necessary. This leads to overlapping of crops. Moreover round the factory there is concentration of area under sugarcane and successive ratooning. All these factors combine to provide certain insects with favourable conditions for rapid multiplication. The sugarcane top-borer has taken advantage of these conditions and has multiplied very rapidly, particularly in the South-Eastern Punjab where it has caused great damage.

Its life-history and seasonal history have been studied and it has been found that there are 5 distinct broods from February when the moths emerge from over-wintered caterpillars to October, when the caterpillars enter into hibernation. In some cases as many as 80% of the shoots have been infested and this number included primary and secondary shoots, tillers, etc.

Certain control measures are discussed.

91. Fruit flies and their economic importance in S. India.

T. V. RAMAKRISHNA AYYAR, Coimbatore.

In a tract like South India where the benefits of a liberal use of fruits in the daily dietary of our households has not yet been sufficiently

appreciated as in many western countries, neither the cultivation of fruit crops nor the study of the diseases and pests they are subject to has received that serious attention which such problems deserve. It is needless to add that fruit trees are as much subject to the attentions of insect pests as are many of our staple food and other cultivated crops and if one takes some trouble to estimate the loss caused by insect pests to our fruit trees it will be found proportionately as substantial as is caused by pests of paddy, cotton, and other crops. Among the various insect pests attacking fruit trees those known popularly as 'Fruit flies' occupy a very important status in all the fruit growing areas of the world. In this province, though we find different kinds of these fruit flies attacking various fruits and damage to crops is often realized, excepting a few systematic references we have hardly any previous records on the bio-nomics of South Indian fruit flies. In these days of quick and easy transportation facilities between different parts of the world insect pests of different kinds get more frequent and easier opportunities of getting dispersed from place to place and in many cases undesirable insects get admission into areas where they were unknown before; among such forms fruit flies play a very important rôle. As such, it is believed that, some knowledge of the general features and habits of these insects might be of help to fruit growers in recognizing a fruit fly when it appears as a pest and adopting prompt measures to control the same. In this paper are presented the results of a study of the fruit flies found in South India with an annotated list of South Indian forms as a preliminary to further research on the different aspects in the biology of these insects.

92. The economic status of the common black ant of South India, *Camponotus* (*Janæmyrmex*) *compressus*, Latr.

P. N. KRISHNA AYYAR, Coimbatore.

Camponotus compressus is one of the most abundant and best known species of ants in South India. It has been noted to range over the greater part of this province. They live in large and very populous communities comprising four distinct types of worker individuals besides the sexual and immature forms. Their habitations consist of a net work of irregular, tortuous under-ground galleries and chambers extending to a depth of three or four feet and communicating with the exterior by means of openings surrounded by mound-like accumulations of loose pellets of earth.

In this paper the economic status of this insect in relation to Agriculture is briefly discussed and it has been considered to be destructive, though in an indirect manner, to a variety of cultivated crops, ornamental and other trees and shrubs by their symbiotic associations with a host of Mealy bugs, Scale insects, Aphids, Fulgorids, Psyllids, and Lycaenid caterpillars. A list of plants in South India seen heavily infested with *Camponotus* and its associates is furnished. The destructive rôle of this species particularly in relation to such crops as Rai, Chulam, Maize, Cotton, Lablab, Red gram, Citrus, etc. together with the extent of damage caused is indicated and it may be observed that this is perhaps the first among the Formicids of South India to attain such distinction.

The life-history of this species including the description and duration of early stages has been worked out in detail perhaps for the first time. An account, based mainly on an extensive series of observations both in the laboratory and the field, of their life habits, swarming season, marriage flight, proportion of sexes, seasonal incidence and census, etc. is given. The efficacy of a few methods of control carried out on an experimental scale, particularly of a solution of potassium cyanide in different proportions, is also discussed.

93. Earthworms as foes of the farmer.

M. AFZAL HUSAIN and K. G. BHANDARI, Lyallpur.

Earthworms, generally useful to the farmers, are decidedly harmful when occurring in very large numbers. In well irrigated areas they make burrows which make irrigation, if not impossible, very expensive. Reports of such interference with agriculture have been received from many parts of the Punjab. Slaked lime dusted over the earthworms, which come out of the soil after rain or irrigation, kills them within a very short time. Various other vermicides have also been tried.

94. Life-history of *Trichogramma*—a chalcid parasitic on the eggs of the Bruchid beetles.

D. D. MUKERJI and M. A. HAKIM BHUYA, Calcutta.

In rearing Bruchid beetles in the laboratory it is found that a species of *Trichogramma*—a chalcid parasite, oviposits on the eggs of the Bruchid beetles. The larva of the parasite grows within the egg of these beetles at the expense of the latter and pupates there. The imagines emerge from the egg shell of the latter through a perforation made on the convex surface of the egg. A very high percentage of eggs of beetles are infested. The infested eggs become arrested in development and ultimately disintegrate.

The parasite is a much more valuable check on injurious Bruchid beetles, than the species of *Bruchiodes* which parasitises the same species.

95. Common aphids in Baluchistan and their natural enemies.

A. C. SEN, Pasni, Baluchistan.

One of the serious pests affecting the fruit-trees and vegetable plants in Baluchistan are the aphids. In the regions of higher altitude, such as Quetta (5,500 feet above sea-level), these pests apparently disappear during severe winter when the temperature falls much below the freezing point.

The common aphids attacking the peach and almond trees are *Lachnus persicae* Chol; these are hyper-parasitized by the natural enemies of Braconid flies—*Aphidius* sp. On the common 'Jowari' crops (*Andropogon sorghum*) there are usually two species which are quite serious, namely *Rhopalosiphum maidis* Fitch and *Rhopalosiphum* sp.; while *Rhopalosiphum sorghi* Theo. attacking the *Phragmites communis* Trin. (common reed), and *Tuberidachnus salignus* Gino, are common pests on willow trees in North Baluchistan. *Peganum harmala*—a desert bush commonly found in Baluchistan is infested by *Brachyunguis karmalae* Das. The cabbages are seriously affected by *Lipaphis pseudobrassicae* Davis. These cabbage aphids were also recovered from the plain area of Sibi district and also from Sukkur district in Sind. These species of cabbage aphids was found to be extensively parasitized by Braconid flies—*Diaeretus* sp.

ANIMAL NUTRITION.

96. Minerals in pasture grasses.

A. VISWANATHA IYER, Bangalore.

This paper deals with the mineral data obtained from pasture grasses grown at three different places, viz. Pusa, Sabour, and Bangalore during:

two consecutive seasons. Four pure species, *Andropogon contortus*, *Andropogon annulatus*, *Cynodon dactylon* and *Pennisetum cenchroides* were grown in these places.

It is very difficult to get all the four species to grow at all the places. Pusa and Bangalore could not grow *Andropogon annulatus* and Pusa could not continue to grow *Andropogon contortus* during the second year.

Judged from the figures obtained it appears that the same species grown at different centres shows marked differences in the mineral composition of its parts and different species grown at the same place also show variations, and the composition also varies from year to year, in some cases very markedly, and in others not so much.

From the figures for Bangalore, it will be noticed that *Cynodon dactylon* and *Pennisetum cenchroides* are much alike in their mineral composition during the two years while *Andropogon contortus* gave a much richer product in 1932 than in 1933. The difference is not due to climate, because the other two grasses show no such variation. This was due to the fact that *Andropogon contortus* was a new plantation in 1932 sown in very deeply and well cultivated land. The rich growth and mineral abundance must therefore be put down solely as the effect of cultivation.

The second point to note is that *Cynodon dactylon* has a tendency to contain more lime than the other species and the lime definitely exceeds the phosphoric acid.

Pennisetum cenchroides contains less lime than *Cynodon dactylon*, but contains more phosphoric acid than lime which is quite unusual. This phenomenon is seen also in the Sabour samples. At Pusa, the lime content is higher than phosphoric acid evidently due to the very high lime content of the soil.

97. An investigation into the effect of manuring and stage of maturity on the yield and mineral composition of pasture grass and their bearing on the mineral requirements of the cattle of the Central Provinces.

D. V. BAL and C. R. ATHAWALE, Nagpur.

Results of yields of local grass, and Economic Botanist's grass mixture show the following :—

- (a) The yield of grass per acre from plots cut at monthly intervals is usually less than that obtained from the plots giving a single cut either at the flowering or at the dead ripe stage.
- (b) The yield of grass whether cut at the flowering or at the dead ripe stage does not show any appreciable variation.
- (c) A dressing of 100 lbs. of ammonium sulphate per acre increases the yield of grass by about 50%.

The percentages of calcium (CaO) and phosphoric acid (P_2O_5) in dry grass are usually more in the case of the local grass than those found in the case of the Economic Botanist's grass mixture.

Grass cut at monthly intervals is somewhat richer in P_2O_5 than that cut at the flowering stage and the latter is somewhat richer than that cut at the dead ripe stage, but such a difference in respect of calcium content of the grass is not noticeable to any appreciable extent.

The mineral content of the grass does not appear to be affected in any way by the various manurial treatments employed.

From the data given by Theiler in respect of minimum and adequate mineral requirements of cattle of average weight and that given in the paper in respect of the percentage composition of the grass, it is considered that ordinarily if the animals can be supplied with the minimum quantity of dry grass required for their maintenance, there would be no danger of deficiency in respect of calcium and phosphoric acid.

In special cases where calcium or phosphoric acid deficiency is likely to occur the cheapest method by which this can be avoided would be to feed the cattle with one ounce of sterilized bone meal per head per day.

98. Assimilation of minerals by farm animals.

A. VISWANATHA IYER, N. KRISHNA IYER, and
N. C. DAS GUPTA, Bangalore.

This paper is a study of the data obtained in recent assimilation experiments carried out by the Nutrition Section. Experiments were conducted with 23 different fodders and nine of these were tested at different stages of maturity, thus bringing up the total number of tests to 36. The mineral content varies from fodder to fodder. It also changes with maturity.

P_2O_5 , MgO and K_2O invariably become less with advance of maturity, whereas the lime variation is not large. An exception to this rule is Jouar, where the lime content shows considerable variation.

All the feeding experiments were carried out with mature bullocks of 750 lbs. average weight on bare maintenance basis judged from the protein balance.

Summing up all the experimental evidence of these tests it is found that, when the intake of P_2O_5 and CaO falls below 10 grams and 15 grams, respectively, there is no positive balance possible even if other conditions are favourable. Under unfavourable conditions a negative balance may result even in cases where the intake is twice or thrice of these minimum quantities.

With the food materials tested at Bangalore it appears that the most favourable condition for avoiding loss of Ca and P is that the resultant urine should be quite alkaline. As the alkalinity decreases, the retention of P_2O_5 and CaO tend to decrease, sometimes resulting in a minus balance. In cases where the urine is acidic, there is definite loss of P_2O_5 and CaO .

99. The provision of succulent fodder for work cattle in Central India.

G. C. TAMBE, C. NAGAR, and T. KRISHNAMOORTHY, Indore.

Inefficient condition of work cattle in Central India and elsewhere at a time when intensive work is expected of them is a serious handicap to agriculture. The best remedy is to ensure continuous supply of succulent feeds and so to escape the effect of recurring periods of malnutrition. A small area under perennial green cereal and leguminous fodder is suitable for growers of irrigated crops and ensiling of rain grown surplus feeds for the dry land cultivator. Preliminary examination of various possible sources followed by a critical quantitative comparison of the more promising ones resulted in establishing the suitability of Sudan grass (*Andropogon Sorghum sudanense*) and the Nasik strain of lucerne for irrigated farms. Silage made in mud-tower silos from the surplus of first cutting of natural grass suits best the requirements of dry-land farmer. One part of cowpeas added to four of grass improves the quality of silage considerably. Cowpeas can be grown as a catch crop during the kharif fallow before wheat, not only without affecting the yield of wheat, but sometimes improving it. The economics of this provision are discussed.

MISCELLANEOUS.

100. Electric ploughing: its uses and comparative advantages.

S. S. NEHRU.

Experience has shown that for ploughing very bad, hard, dry soils which particularly want deep ploughing the ordinary explosion motor fails to give satisfaction. Alternatively, steam tackle may be indicated but the difficulties are that good water is not available and bad water ruins the boilers. Also there may be difficulty in procuring sufficient supplies of coal and water at reasonable cost. In such cases, an electro-motor has been used with striking success. Details and figures are given.

101. The application of electrocultural methods to fruit-farming.

S. S. NEHRU.

Electrocultural methods have been applied to a very wide variety of fruit trees, such as (1) Falsa (*Grewia asiatica*); (2) Mulberry (*Morus indica*); (3) Guava (*Psidium guajava*); (4) Lemon (*Citrus medica*); (5) Custard apple (*Anona squamosa*); (6) Gular (*Ficus glomerata*); (7) Jamun (*Eugenia jambolana*); (8) Mango (*Mangifera indica*); and (9) Mahua (*Bassia latifolia*). A definite and satisfactory response has been obtained in every case. Detailed results will be communicated and the latest ones included.

102. Cotton survey of Osmanabad District in H.E.H. The Nizam's Dominions.

B. B. MULCHANDANI and N. R. YARDI, Parbhani.

The Indian Central Cotton Committee sanctioned the Hyderabad Cotton Botanical Survey Scheme in 1931 and since then the work is in progress. Osmanabad district was surveyed in 1932 and 1933. Out of 1,31,000 acres, 402 acres were surveyed in 23 well scattered villages throughout the district.

Three species *G. hirsutum* (American cotton), *G. indicum*, *G. neglectum* species were found in varying proportions in the district. None of the fields examined or seed samples grown at Government Experimental Farm, Parbhani, contained a single species or variety in pure form.

The cotton crop of Latur, Osmanabad, and Kallam taluqas had got 58% *G. indicum*, 34% *G. hirsutum* and the rest being *G. neglectum* plants. *G. neglectum* plants were present to the extent of about 52%, *G. indicum* 39%, and *G. hirsutum* 9% in cottons of Parenda and Tuljapur taluqas.

In the *G. neglectum* species, rosea variety dominated to the extent of about 90%.

103. Hand refractometer tests with Pundia and E.K. 28 sugarcane varieties.

B. P. VAGHOLKAR and N. B. PATWARDHAN, Padegaon.

Hand refractometer (Zeiss) was used to (1) compare puncture brix internode by internode with pressed brix, and (2) to see at what internode average representative brix is possible to give a representative idea. Pundia and E.K. 28 were the varieties with which the tests were made. It is found that pressed brix is higher than punctured brix and further it is observed that fixing a definite internode for puncture brix is not suitable for all the varieties and it would thus be essential to carry out detailed study on each variety before fixing an internode.

104. A method of botanical observation to suit both the flowering and non-flowering varieties of sugarcane.

R. D. REGE and P. V. WAGLE, Padegaon.

The standard method of botanical observations consists in the measurement of height which is taken up to the highest visible leaf mark at the junction of leaf blade and leaf sheath. Though this method is found to give fairly reliable results in the non-flowering varieties, it is very deceptive as regards the flowering ones specially at the flowering time. At this period there is a shooting of the inflorescence which leads to rapid increase in height but which is found practically to add very little to the millable cane. In fact, by following this method the maximum increase in height in P.O.J. 2878 is obtained during the months of October and November (the flowering period), while considered from the standpoint of yield, the growth of the cane is completed before this period. The standard method thus gives quite an erroneous conception as regards the growing period of cane and is modified accordingly. The modified method is further described in detail.

105. A simple method to estimate the wilting stage.

R. D. REGE and P. V. WAGLE, Padegaon.

During the course of wilting coefficient experiments it was thought essential to have a suitable quantitative method for the wilting stage. The standard method as recommended in the text books is not possible in the field studies as it requires removal of the plant to humid chamber. It was thought that just when the plant is to attain the permanent wilting stage, the assimilatory activities of the leaves would be at a standstill and as such there would not be increase of organic matter due to photosynthesis during the course of the day. Ganong's leaf punch method was therefore tried and it has given very promising results.

Section of Medical and Veterinary Research.

President :—MAJOR K. R. K. IYENGAR, M.D.,
D.P.H., I.M.S.

Presidential Address.

RABIES.

LADIES AND GENTLEMEN,

Let me begin by expressing my thanks to those who have honoured me by asking me to become President of the Medical and Veterinary Research Section of the Indian Science Congress this year. As my energies have been for some time confined to work on Rabies, I have chosen that disease for my address.

Rabies has been known to mankind for over 2,000 years. In the earliest pages of the history of medicine, there is evidence of a very remarkable knowledge as to the character of rabic infection. The first reliable information of this disease among dogs is found in Aristotle (B.C. 322), who was familiar with the spreading of the disease from dog to dog by means of the bite. Later, medical and lay writers of antiquity accurately described the symptoms, including those of human rabies, and advocated the cauterizing of wounds as the only protection from developing the disease, but during the succeeding 16 centuries very little progress was made in the realm of the etiology of the disease.

In 1804, Zinke observed that the saliva of dogs was infective, and he artificially infected healthy dogs, rabbits, and fowls with rabies by painting the saliva of rabid dogs into freshly made wounds. This was the beginning of experimental research work in rabies.

From 1881-1888 Pasteur, by a series of brilliant researches, proved the constant occurrence of the rabies virus in the central nervous system of diseased animals. He further showed that other animals could be infected with it by direct inoculation upon the surface of the brain, and this resulted in the method of certain diagnosis of rabies. He offered to the world a method which would overcome the infection after it was received by the inoculation of the rabbit fixed virus in various stages of attenuation, and thereby placed the coping stone upon a life-work which has transformed the whole face of medical theory. As the immunity response appeared analogous to that met in bacterial diseases, Pasteur considered he was dealing with an organism which he was unable to see with the microscope then available. Up to date no discovery concerning the disease is on a par with

the classical work done by him. The failure to isolate the virus and cultivate it was still the main difficulty in making progress.

In 1903, Negri described the bodies, now called by his name, found within the cytoplasm of the nerve cells and of their processes, and he claimed that they were in the nature of protozoa and are the true causative parasite of rabies. These bodies, varying greatly in size, are found in all parts of the nervous system, but are most readily demonstrable in the cells of the horn of Ammon (hippocampus major), and in the Purkinjee cells of the Cerebellum. They are found regularly in fresh 'street virus' material and their presence is increasingly difficult to detect according to the number of passages the virus has made through rabbits. In 'fixed virus' infection they are hardly found. Though the infection is carried through the saliva of biting animals, still these bodies have never been found in the saliva, the salivary glands, and the nerves. There is no doubt that, in the presence of Negri body, we have a diagnostic character of great value, but the question naturally arises 'Are they the true causative parasites of rabies?' The 'fixed virus' is derived from the 'street virus' and the symptoms in the 'fixed virus' infection in animals are the same as in the 'street virus' infection, but still these bodies are hardly ever found in brains of animals which have died of fixed virus infection. It has been proved that the rabies virus can pass through filter bougies. It is just possible that these bodies represent the visible phase in the cycle of evolution of the virus, but it is more than probable that these are not the true parasites but a product of cellular action against a filtrable virus. The delicate structure of Negri bodies has been examined by countless research workers who, while confirming in the main Negri's description, have not yet arrived at any definite conclusion concerning the importance of the discovery.

Of the many experiments carried out in the cultivation of rabies virus, not one can stand criticism. A successful cultivation would provide the correct basis for prophylaxis as well as for a specific therapy. In 1913, Noguchi claimed to have grown successfully the rabies virus in test tubes, but he could not proceed with the work, and every one who has repeated his procedure has failed to confirm his results. Although the nature of the causative agent is still unsettled, it must, however, receive consideration in any discussion on diseases caused by filtrable viruses.

Last year, work was carried out at the Pasteur Institute, Coonoor, in order to find out the electric charge carried by the rabies virus. The method adopted for this purpose involved the use of electrophoresis. The experiments consisted in passing a 4-milliampere current through a 5 per cent. suspension of infected rabbit brain in sheep serum, and after a time, samples collected at each of the poles were subjected to

appropriate biological tests. It was found that the contents of the positive cell produced rabies on subdural inoculation to rabbits, while the contents of the negative cell did not. This clearly proves that the rabies virus is electro-negatively charged and migrates towards the positive pole, within certain limits of pH.

In view of the great difference of the virus content of the different parts of the brain, the vaccine as used now can only be taken as a crude one. Now that we know that the virus has an electro-negative charge, we can isolate the virus in a pure form at the positive pole, thereby getting rid of the tissue proteins, and this may be the means of preparing a more highly concentrated antirabic vaccine than has hitherto been possible. Further experiments as to the antigenic value of this vaccine as compared with that of the crude vaccine are in progress.

We have further found that the vaccine can be sterilized by exposure for 10 minutes to radiation from a quartz mercury lamp and the antigenic value of the vaccine so inactivated has in no way deteriorated. A mercury vapour lamp gives radiation of wavelength from 6,500 A.U. to very nearly 1,800 A.U., and there is evidence that the shorter wavelength of light, such as ultra-violet 4,000 to 1,800 A.U., are highly inactivating. This method of sterilizing the vaccine is a great advance on the present methods adopted by the use of chemicals, such as carbolic acid and formalin.

In nature, a multiplicity of 'street viruses' exist varying in their pathogenicity. The 'fixed viruses' derived from them are similarly different from one another, especially from the point of view of their antigenic value. As regards the strain of virus to be used in the preparation of the vaccine, 'Paris' strain of fixed virus has been proved to confer a more solid immunity than the 'Kasauli' fixed virus (isolated from a dog at Kasauli) and is in general use in all the Pasteur Institutes in this country. The vaccine now employed in treatment is of higher strength—5% instead of 1%—and the dosage has been greatly increased in the severely bitten. The greater the risk, the bigger the dosage within certain limits, is the principle observed in the treatment of human cases. It is a remarkable fact that since the introduction of the 'Paris' strain of fixed virus and the higher dosage, there is a marked fall in the total mortality rate. Though the evidence is uncontrolled and has not the same statistical value of the alternative case observations, still it is very significant that this considerable lowering of mortality rate for two years in succession should correspond exactly with the introduction of the exclusive use of the 'Paris' strain of fixed virus combined with the higher dosage.

In many of the Pasteur Institutes in Europe, a live vaccine is preferred to a killed vaccine in the treatment of cases. There is no evidence whatsoever of the existence of a superiority of

treatment by live vaccines over the treatment by killed vaccines. Moreover, the liability to accidents from the use of live vaccines is much greater than the liability from killed vaccines. In the present state of our knowledge about the etiology of the disease, it is out of question for any of the Pasteur Institutes in India to adopt a live vaccine in preference to the dead vaccine.

By far the largest proportion of persons who come to anti-rabic institutes for treatment have been bitten by dogs. Dogs must, therefore, be regarded as the chief agents in producing mortality from hydrophobia in man. Jackals inflict about 5 per cent. of the bites; cats a still smaller proportion; whilst other animals may be left out of consideration. If rabies amongst dogs were to be practically eliminated, not only would the greater number of deaths from hydrophobia in man be prevented, but also a large number of cattle and domestic animals would be saved. Stray dogs, when rabid, set up foci of infection here, there, and everywhere, until they succumb to the disease.

I do not imagine for a moment that it will be possible to suppress rabies completely in a country like ours within a reasonable number of years, but I have no doubt that it can be controlled sufficiently to reduce the annual mortality to an almost negligible quantity. Rabies primarily is a disease of dogs; only occasionally is it communicated to other animals and to man. It is the wrong procedure to treat cases as they arise and to take no steps whatever to control the dog population. Many anti-rabic institutes have been established for curative purposes, while preventive measures have been neglected. This, I am sure you will all agree with me, is wrong in principle. Steps should be taken to deal with the disease at its source.

In Germany, rabies has been so successfully controlled that it is now regarded as entirely a frontier disease, that is to say, every case in man and animals can be traced to an importation, and rigorous preventive measures are promptly taken. In Australia, I believe that rabies is now unknown. In the British Isles the muzzling order was introduced, followed by the quarantine of all imported dogs, and this has resulted in the eradication of the disease within a few years. At the time there was a public outcry against these orders, but yet the end justified the means, and persistence was crowned with success.

To control rabies, dogs must be controlled; and if any class or individual is beyond control, they must be gradually eliminated and not allowed again to come into existence. In this endeavour the State and the public are interested, and earnest co-operation is necessary on all sides if anything is to be achieved in the way of regulating the dog nuisance and the danger from rabies. Any scheme to be effective must have the hearty co-operation of all the authorities concerned. It would scarcely be worth while to attempt any measures of control, unless they were adopted universally in the land. All dogs which have no real

owner, who will accept any responsibility for them, are under no control and they must all be destroyed. There is a very large class of dogs which are attached to no house or person, and which procure an insufficient supply of food from the garbage of towns and villages. A misguided sentimentality prevents the destruction of these stray dogs. No other animal is as intimate psychically and physically with man as the dog. Rules and regulations to control the dog population should appeal to both dog lovers and humanitarians. The neglect of this simple remedy for such a dread disease, which is 100 per cent. fatal, reflects upon the logic and intelligence of ourselves and our contemporaries.

Registration and licensing of dogs must be enforced by all municipalities and district boards. The licensing fee must be fairly high to prevent persons who can ill-afford to keep dogs from owning them. Any person possessing a dog without a license should be heavily fined. Lethal chambers must be established for the destruction of all ownerless dogs. Clubbing, poisoning, and the shooting of them in the streets are out of the question. All railway companies should make arrangements to destroy stray dogs found in railway station premises.

In rural areas, besides the destruction of stray dogs, jackals also should be destroyed, as no doubt a certain percentage of dogs get their infection from this source.

No useful purpose would be served at the present time by the quarantine of dogs imported from foreign countries, while rabies is so prevalent within the land. Only when we have perfected the system of controlling the local dog population, should attention be paid to the quarantine of imported dogs. At present, most of these dogs come from Australia and England where no rabies exists.

A considerable amount of time has been devoted to work in connection with rabies, but little of immediate value has been ascertained. All attempts to cultivate the organism artificially have failed, and all efforts to prepare serum and devise more efficacious means of prophylactic treatment than those in general use now have ended in disappointment. Until the organism has been cultivated artificially, it will not be possible to improve greatly on the somewhat crude method which is now employed. All future research work on rabies should concentrate on the identification of the virus and its growth on artificial media. Once this is done, the necessity for so many Pasteur Institutes in India will not exist. One All-India Pasteur Institute, whose functions would be to manufacture the vaccine and to carry out research work, would be sufficient.

In conclusion, I would like to say a few words on the question of decentralization of antirabic treatment. The Pasteur Institute, Coonoor, was the first Institute in this country to start the broadcasting of the antirabic vaccine treatment and

at present there are 108 centres in the Madras Presidency and in the Native States. Within the next few years, the number of centres will be nearly doubled, thereby making the treatment available nearer the homes of the persons bitten. The objection raised to broadcasting the vaccine on account of the high temperature prevailing in the plains does not stand scrutiny. We are not dealing with a living virus like smallpox vaccine, but a dead vaccine in every way comparable to T.A.B. and cholera vaccines. The precautions deemed necessary for the latter will suffice for the former. There are enough reliable data available to show that the results obtained by medical officers using the vaccine in the plains are just as good as those obtained at Coonoor. Decentralization of treatment, instead of centralization, must, in future, be the policy of all Pasteur Institutes.

Section of Medical and Veterinary Research.

Abstracts.

1. A preliminary note on the rôle of malaria in the causation of cirrhosis of the liver.

T. S. TIRUMURTI and N. V. RADHAKRISHNA RAO,
Vizagapatam.

The common association of malaria and cirrhosis of the liver in India has given rise to divergence of opinion, regarding the rôle of the former in the causation of the latter. Brief reference is made to the views of some of the workers in India, and the importance of the problem is pointed out. Judging from personal experience, it is concluded that malaria *per se* is not a direct cause of cirrhosis of the liver.

2. Bronchiectasis—its etiology, diagnosis, prognosis and treatment.

A. C. UKIL and K. N. DE, Calcutta.

The paper is based on 100 cases of bronchiectasis diagnosed by intratracheal introduction of Lipiodol. It was believed that bronchiectasis was a rare condition in India. The authors' evidence shows that it is not so. The etiological factors, the localization and the different types met with have been described. The prognosis and treatment have been briefly dealt with.

3. Abscess and gangrene of the lung.

A. C. UKIL and K. N. DE, Calcutta.

The paper is based on 15 cases diagnosed and observed by the authors. Their localization, etiological factors, diagnosis, prognosis and treatment have been briefly described. The selection of cases for treatment by various methods, such as arsenical preparations, sero-therapy, bronchoscopic drainage and artificial pneumothorax has been indicated and the results of treatment by each method communicated.

4. The effect of bacteriophage on the enzyme activity of vibrio cholerae—Part I. Reducing enzymes.

N. R. CHATTERJEE, D. N. CHATTERJEE, C. L. PASRICHA, and
SUDHAMOY GHOSH, Calcutta.

This is the first of a series of studies undertaken with a view to determine the activity of the different enzymes of cholera and the so-called cholera-like vibrios and also the effect of different types of cholera-phage and vibriophage individually and in different combinations on such activity. Preliminary investigations had shown that there was considerable alteration in enzyme activity and it was decided to study the problem in detail. The present study was confined to the reducing enzymes of cholera vibrio, with and without the preliminary action of phage. The amount of reduction of a nitrate to nitrite was estimated quantitatively by the standard colorimetric method followed in water analysis. A constant volume of a 24 hours' peptone-water culture of the strain was

inoculated into known volumes of a simple culture medium and placed in an incubator. Uninoculated tubes of medium were incubated with the others and used as controls, and the amount of nitrite formed was estimated at known intervals. The results are discussed with the use of graphs.

5. Cholera kidney,—a histological study.

D. N. BANERJEE and S. K. DUTTA, Calcutta.

26 specimens of cholera kidney have been studied including 5 cases who died as a result of cholera uræmia with total anuria for several days. The histological study has been carried out with the usual staining reagents but more particularly with Mallory's anilin blue (modified) and Ohmorie's rein blue-picric acid methods which clearly show the glomerular basement membrane and thus avoids any confusion between glomerular epithelium and endothelium.

It is a curious fact that cholera kidney shows either macroscopically or microscopically (by usual histological technique) very little pathological evidence which again is quite out of proportion to the drastic renal symptoms produced by these changes.

By using special histological technique the examination of the present series shows evidence of gross change in the glomeruli and in the convoluted tubules, the chief findings being complete or partial destruction of the tuft, thickening of the basement membrane of the glomerulus as well as that of the Bowman's capsule with increase in the number of cells specially the visceral and parietal epithelial cells of the capsule. Focal necrosis of the glomerular tuft is also present in fair number of specimens. The convoluted tubules show albuminous and hyalin-droplet degenerative changes.

6. Cholera kidney—a clinical, biochemical and functional study.

D. N. BANERJEE and S. K. DUTTA, Calcutta.

50 cases of cholera with anuria have been studied. The majority of them had suppression of urine for a period varying from 24 to 72 hours, while in some case urine being established after temporary suppression was followed by complete anuria and death.

In all cases total non-protein nitrogen, urea, uric acid, creatinin were greatly increased, chloride and cholesterol content normal or less than normal. Blood pressure was raised only in a few fatal cases.

In fatal cases with permanent suppression of urine unconsciousness with violent delirium and hurried breathing was present. Urine was highly acid with high specific gravity, moderate amount of albumen, innumerable hyaline, granular, leucocytic and epithelial casts and red blood cells in some cases. Uric acid and urates of all forms were also present.

After establishment of urine, water elimination test was greatly impaired, though no sign of fluid loss was present. Phenol Red excretion was delayed. The nonprotein nitrogen and kidney function test and the urinary changes came to normal within a few days after the establishment of urine in a majority of cases.

7. A new curative anticholera serum and its therapeutic use.

H. GHOSH, Calcutta.

An anticholera serum has been prepared with a toxin obtained by culturing a single strain of *Vib. Cholera* anaerobically in alkaline broth. The broth filtrate was used for immunization of horses. The serum was

concentrated. The agglutinating titre of the serum was found to be 1 in 12,000. This serum was tried on cholera patients during the last epidemic of cholera in Calcutta. The injection was given intraperitonially. The encouraging results obtained are given in the chart.

8. The reticulocyte count in malaria and kala-azar and its diagnostic value.

T. BHASKARA MENON, D. RAM ANNAMALAI, and T. N. KRISHNASWAMI, Madras.

A high reticulocyte count has been recorded in acute malaria and post-malarial anæmia, since the bone marrow response is adequate in the early stages of the infection. In order to determine if this is sufficiently high in chronic malaria, to be of value in the clinical differentiation between malaria, kala-azar, and other types of tropical spleno-megalies, counts were recorded in Chronic Malaria and Kala-azar. The results are discussed in this paper.

9. The incidence of hepatic cirrhosis in South India.

T. BHASKARA MENON and D. RAM ANNAMALAI, Madras.

A study of autopsy records, hospital statistics, and returns of the Health Department of the Corporation of Madras, shows a high incidence of hepatic cirrhosis in Madras. This is in keeping with the high incidence recorded by Rogers in Bengal. The type of cirrhosis is described. A survey of the aetiological factors is made.

10. A possible aetiological agent in infantile cirrhosis.

T. BHASKARA MENON and D. RAM ANNAMALAI, Madras.

A critical survey of the aetiological factors that were attributed to this condition, from time after time, is made. It is suggested that the cirrhosis is essentially toxic. A possible aetiological factor is put forward as responsible for the toxic change in the liver.

11. Some pathological changes in filarial orchitis.

T. BHASKARA MENON and D. RAM ANNAMALAI, Madras.

The evidence put forward of definite inflammatory change directly due to the presence of *Wuchereria Bancrofti* in the lymphatics of the testis is against the view that the parent worms themselves are innocuous.

12. The venereal origin of 'Granuloma inguinale'.

T. BHASKARA MENON and P. NATESAN, Madras.

The venereal origin of 'Granuloma inguinale' has been questioned. A few case-histories are recorded where there is suggestive evidence of venereal infection.

13. The vitamin C content of some Indian foodstuffs.

S. RANGANATHAN, Coonoor.

The isolation and identification of vitamin C as a single chemical substance, termed ascorbic acid by Professor Szent-Gyorgyi, provoked several attempts to evolve a simple and direct method of estimating it. The most successful of these attempts is that employing the oxidation-reduction indicator, 2,6-dichlorophenolindophenol, first employed for this purpose by Tillmans and his associates. Several improvements were

effected in the original method of Tillmans, notably by Birch *et al*, Kertesz, Wolff *et al*, and by Bessey and King. The method finally evolved by Bessey and King was employed in the present investigation with slight modifications designed to reduce the time required for a determination. The oxidation-reduction indicator was prepared from 2-6-dichloro-quinonechloroimide and standardized by the procedure outlined by Bessey and King. The vitamin C content of 100 Indian foodstuffs was determined. Some of the common articles of food, like *Amaranth* and other leafy vegetables allied to it, and green chillies, were found to contain unexpectedly large amounts of vitamin C (*Amaranth*, 175 mgs. and green chillies, 135 mgs. per cent. of edible portion). It was also found that a considerable loss of the antiscorbutic vitamin occurred on storage, the loss during 24 hours amounting to nearly 50 per cent. in the case of spinach. The observation of Bacharach and his co-workers of a steady fall in the vitamin C concentration as one proceeds from the outside to the inside of the orange (the peel containing 4 to 5 times the amount present in the juice), was confirmed. On the basis of this observation, Bacharach and his co-workers suggest that the origin of vitamin C is probably related to photosynthesis. This suggestion, interesting though it is, does not find confirmation in the case of plantain, where the peel does not contain any vitamin C whatsoever while the edible portion inside contains about 8 to 24 mgs. per cent.

14. Cereals and calcium and magnesium assimilation.

S. RANGANATHAN, Coonoor.

With a view to ascertaining whether cereals differ in their capacity to promote calcium and magnesium retention on diets made up exclusively of the cereal, metabolic studies were undertaken in albino rats. Five of the common cereal grains in use in India, viz. whole wheat, cambu, cholam, ragi, and polished rice, were investigated from this aspect. The retention of calcium was good, both in the amount retained and as a percentage of the intake of this element, in the animals fed exclusively on wheat and polished rice diets; the retention was fair in those fed on cholam and ragi diets while it was comparatively poor in those fed on the cambu diet. As regards magnesium, the animals fed on wheat and polished rice diets only were in positive balance, while negative balance of varying degree was encountered in animals fed on cambu, cholam, and ragi diets. The phosphorus balance was positive on all the diets. The growth of the animals was poor on all the diets, but those fed on wheat, cambu, and cholam diets exhibited relatively better growth than those fed on ragi and rice diets. during the period the animals were under experimentation.

15. Investigations about the effects of humidity and high temperature on the amine content of different samples of rice.

N. M. BASU and S. R. MAITRA, Calcutta.

The prevalence of epidemic dropsy in Calcutta during the rainy season when air is saturated with moisture at high temperature, the maximum temperature varying from 80° to 95°F, especially in rice-godowns, led us to investigate the changes in the amine content of rice under these conditions, as it is known that some amines cause capillary dilatation leading to dropsy which is such a prominent symptom of the disease. Samples of rice freshly milled by indigenous methods (i.e. *Dheñki-ohhātā-chāl*) were obtained from Burdwan and samples of milled rice from the

College Street Market. These were kept in dishes in an incubator along with a dish of water so that the air inside is saturated with moisture and the temperature of the incubator was kept constant at 38°C. The samples of rice thus treated were examined on alternate days for a period of one month for their amino-N₂ content by Van Slyke's method, modified slightly in accordance with our needs. The exact procedure will be discussed in the paper which will be submitted later on. Results of these analyses show that there was a gradual increase in the amino-N₂ content of all samples of rice, but this increase was more marked in the case of milled rice than in the case of rice milled by indigenous methods (i.e., Dheñki-chhāṭā chāl).

16. Vitamin A content of some Cauvery and sea fish.

B. N. BANERJEE, Bangalore.

The body oil of *Kenday meen*, *Kelathy meen*, *Curromule candee meen*, *Aral meen*, *Wennatti meen*, *Patcha Parlu meen*, *Karambay meen*, *Charpua meen* (Cauvery fish) and *Kola meen*, *Kadiran meen*, *Mullet*, *Chambally meen*, *Khadla meen*, *Natchakha meen*, *Olakha meen* (Sea fish, Cochin) have been examined for their vitamin A contents by the colorimetric method. The iron and copper contents have also been determined to find out their food value which are consumed locally.

17. Use of spectrographs in medical research.

N. K. DE, Coonoor.

With the advent of new spectrographs and modern equipments, the science of spectroscopy has been applied to a wider range of problems, viz. physiology, pathology, toxicology, pharmacology, and purity control of foodstuffs. Analyses by emission and absorption spectra provide a rapid means of determining the entire metallic and various organic constituents (proteins, purines, sterols, pigments, pro-vitamins, and vitamins A, B₁, D, etc.) of any biological material (body fluids, organs, foodstuffs, plant, and vegetable tissues) liquid or solid, normal or pathological. The investigations notably by Ramage, Sheldon, Zbinden, Kahlenberg and others on emission spectra; and by Bendien, Mortorn, Lewis, Bowden, Snow, Drummond and others on absorption spectra have contributed much towards the progress of both biochemical and medical researches.

Spectrographic work done so far in India under the Indian Research Fund Association consists of the following: (1) A study of the metallic constituents of various foodstuffs and organs (Boyd and De). (2) Estimation of the manganese content of some foodstuffs and organs (Boyd and De). Wheat was found to be very rich while rice was very poor in manganese. These observations support McCarrison's theory of the importance of manganese in nutrition. (3) Estimation of the vitamin A content of some oils and fats (De). (4) Spectrographic analyses of milk from different species, viz. woman, cow, goat, and buffalo (De). The vitamin values so estimated have been expressed in rat and in absolute units. Comparative figures for the vitamin content and mineral constituents of different milks are interesting. (5) Studies on vitamin B₁ (Sankaran and De). The International Standard Preparation of vitamin B₁ has been found to migrate under an electric field. A bipolar migration was observed between the levels of pH ranging from 1.93 to 3.95. The vitamin was shown to have an isoelectric point at about pH₃. It seems that this preparation of vitamin B₁ is not a single substance but a complex of several units (B₃, B₄, B₅, etc.) having close but different isoelectric points. Fractional electrophoresis and other physico-chemical experiments are in progress to isolate these units.

18. A simple form of electro-dialyser.

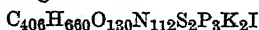
G. SANKARAN, Coonoor.

The application of this apparatus is mostly in preparing pure proteins in an undenatured condition. A protein is usually obtained as a precipitate by the addition of different concentrations of ammonium sulphate. Removal of the precipitate by alcohol, ether, etc. results in denaturation of the protein. Simple dialysis is a very tedious and time consuming process. Electro-dialysis is the method of choice. The device to be described can be fitted with the simplest pieces of laboratory ware available in most laboratories and provided with a direct current electrical plug. Even the ordinary 220 volts D.C. of a town supply can be used direct. The protein precipitate is placed between two parchment thimbles, one inside the other. Into the central thimble is introduced a carbon electrode obtained from a discarded electrical dry cell. Distilled water is constantly passed into this thimble and overflows. The whole is immersed in a beaker of distilled water which also is constantly renewed. Two other carbon rods form the other pole of the circuit. By introducing a very cheap radio variable rheostat a current of about 4 to 5 milliamps on a voltage of 200 Volts D.C. can be passed. The central pole is connected to a negative pole where NH_4 ions collect. The overflow from this pole is tested with Nezelers reagent. The last traces of ammonium salts can be removed within a week's time which by ordinary dialysis would perhaps take at least a month. Further, it is to be known when dialysis is complete which is not possible by ordinary dialysis methods. It is claimed that a test of fluid round the negative pole is very sensitive.

19. A preliminary note on the molecular formula of thyroglobulin.

G. SANKARAN and M. PATNAIK, Coonoor.

Thyroglobulin though a very important protein of the animal body has not been studied to the extent that it deserves. For example, nobody has as yet determined the molecular formula or weight of this protein. The methods the authors propose to adopt are analytical and physico-chemical. The present note gives the results of the analysis of the electro-dialyzed protein—by the method given in the previous paper—for the various elements. By the usual qualitative methods of analysis the following elements were detected: carbon, nitrogen, sulphur, phosphorus, potassium, and iodine. Hydrogen and oxygen are obviously presumed. Quantitative analysis gave the relative proportions of the detectable elements and carbon, hydrogen and oxygen by difference. Contrary to the findings of other workers the authors have consistently found phosphorus in the protein. Just as for hæmoglobin iron is taken to work out the empirical formula, the authors have used iodine for thyroglobulin. As at present worked out it gives:



The formula resembles that given for most proteins (globulins).

(It is not yet certain if Potassium is a necessary element in the protein.)

Further work is in progress.

20. Tissue-culture and its application to medical research.

G. SANKARAN, Coonoor.

'Cell-culture', 'Tissue-culture', 'Explanation', '*Gewebe zuchtung*', and 'the cultivation of cells and tissues *in vitro*'; are terms applied to the cultivation, outside the organism, of various types of cells that have been explanted from the Metazoa. Harrison (1907) was the first to

demonstrate the method. But it was Alexis Carrel who realized the importance of Harrison's work and developed the technique with the assistance of a band of young and enthusiastic workers. The use of the term 'Tissue-culture' might be taken to imply that this method of Research—in reality a Technique—is an object in itself, whereas it is a very valuable means of investigating the properties of cells under conditions previously not available. R. G. Harrison in his opening address at the 10th International Zoological Congress, Budapest (1927), said: 'Tissue-culture has proved of particular value in the fields of embryology, histology, physiology, pathology, and immunology'. It appears then that this new method of Research is even from the view-point of pure biologists, of great value to medical workers. Alexis Carrel (1925) said that the 'main object of Tissue culture is the study of the fundamental problems in Physiology and Pathology', obviously the ground work of Medical Science. Dr. Honor B. Fell in an address given at Cambridge in 1928, said 'The possibilities of tissue-culture as a method for many forms of medical investigations are yet not fully realized'.

A brief survey of work under the following heads will be discussed, embryology, histology, physiology, pathology, and immunology. The applications to the immediate problems of medical research, in particular to those of nutrition, will be indicated.

21. Prognosis in leprosy.

E. MUIR, Calcutta.

The more dreaded a disease is, the more important does an accurate prognosis become.

In acute diseases like pneumonia or cholera there is often little room or time for prognosis till after the crisis has passed.

In leprosy there is abundant time and ample opportunity for judging the chances of recovery. Roughly speaking all cases may be divided into resistant and non-resistant cases, the latter being sub-divided into those who are permanently and those only temporarily non-resistant. In classifying cases, experience of clinical symptoms, the leprolin test and the sedimentation test are invaluable. It is chiefly on a clear understanding of the factors which underlie resistance that a reliable prognosis can be made.

22. Radiological observation in special diseases of the skeletal system.

M. J. S. PILLAI, Madras.

A comparative radiological study describing the skeletal changes in 'Achondroplasia, Acromegaly, Paget's Disease, Leontosis Ossea, Perthe's Disease, Fragilitas Ossea, Diaphyseal Achalasia and Cranio-cleido-dysarthrosis, and the pathological lesions accompanying the conditions are noted.

This apparently heterogenous group of conditions according to the author seem to arise either as a result of deficiency, excess or disordered metabolism of calcium and deciding factors being the anterior pituitary with the co-ordination of other endocrines, the parathyroids in particular. The common tissue involved in all the conditions is the bony tissue derived from the mesoblastic layer of the lesion bringing about an altered relationship between the serous and fibrous layers of the periosteum, mainly accompanied by corresponding changes in the medulla, cortex, and the cancellous tissue.

In the paper all the possible causes for bringing about such pathological changes in the skeletal system and the various influences that are brought to bear upon these lesions by the different endocrines and the changes in the calcium metabolism in these lesions, both hexogenous

and endogenous, are discussed. The author thinks it is possible that disorganization of the normal working of the endocrines can be brought about through infective agency as well, as in Perthe's disease; the other diseases such as Legg's, Kohler's, Schlatter's, and Kamal's etc. are described as the same pathological entity. It is noted that the affection of the epiphysis is not confined to the particular bones with which the above-mentioned names are associated, but has been uniformly found in all epiphysal regions. A number of the radiograms of these several conditions have been appended illustrating fully the subject under discussion.

23. Dysentery syndrome and the sprue complex.

M. J. S. PILLAI and K. N. MURTHI, Madras.

A study of 1,215 cases of dysentery and 102 cases of sprue was made. In the case of dysentery, the period of observation related to the years 1929 to 1931. A graph plotting the seasonal variation of both the diseases is shown. Interesting cases regarding the occurrence and exacerbation of both the diseases in relation to humidity, temperature, and water-supply are also recorded.

The authors view sprue as a complex, following flexner or amœbic infection only in a few cases, while many people suffering for years from dysentery failed to develop the sprue syndrome. They allege that allergy is one of the possible etiological factors in sprue, and further adduce evidence as to why we meet with cases of sprue in various stages. They believe in the bi-lateral representation of functional activities of the specialized organs; of the presence of numerous cells lying dormant, which resurrect themselves as it were in times of emergency, viz. with regeneration of the partially disabled cells and replacement of the completely disorganized ones. This general principle is sought to be applied to the condition under investigation to the various stages of sprue. They also postulate that in all specialized organs with bi-lateral representation, there is a tendency for alternating cyclic action of each of the pair of organs; and in single organs there are a number of cells which though dormant take the activities of the disabled and the degenerated cells, in particular lesions, as in sprue, where periods of quiescence, exacerbation and recovery, partial or complete, are explained by the above mentioned observations.

24. A further investigation into the causal factors concerned in sprue.

M. J. S. PILLAI and K. N. MURTHI, Madras.

The detailed data available of cases under recent investigation show evidence to conform to the conditions detailed in their preliminary paper published in the year 1931. Another independent worker Dr. Flora Innes working on different lines had also perforce to come to acknowledge the two types of sprue defined in their earlier paper.

The evidence of the involvement of the particular cells of pancreas—cells responsible for lipolytic metabolism—has been traced as an additional causal factor in sprue, in addition to the involvement of caecum and gall-bladder. (X-ray photographs appended.)

So far it has not been found possible to verify the aforesaid conditions by post-mortem examination, there being not a single authentic case of sprue in the long records of the Government General Hospital, Madras. The position may be explained by the fact that the patient usually recovers (under dietetic and radiation treatment) enough strength and courage to roam away from the hospital, and we lose sight of him. We are on the look out for such cases.

25. On a method of determining percentage hæmolysis of blood caused by various hæmolytic agents.

N. M. BASU and B. P. DATTA, Calcutta.

In investigating the effects of certain reagents on the inhibition of hæmolysis caused by cobra-venom, the authors were confronted with the difficulty of determining the percentage hæmolysis of blood. They tried to estimate percentage hæmolysis with the help of Lovibond's tintometer as modified by Rosenheim. It was noticed that the coloured glasses of this tintometer do not match the various shades of red colour produced in blood hæmolized to different degrees. They then tried to adopt E. Ponder's selenium cell method. The arrangement of the apparatus as was worked out by E. Ponder, F.R.S., failed to detect slight changes in the conductivity of the selenium cell caused by the incidence of different amounts of light that will be filtered through blood which has been hæmolized to different degrees, as the ratio of this change in conductivity to the intensity of the current flowing through the galvanometer is very very small. This arrangement was therefore modified so as to reduce the intensity of current flowing through the galvanometer. This modification yielded better but not quite satisfactory results. The application of the bridge method for measuring very small resistances in an electrical circuit was applied and very satisfactory results were obtained. But when the authors tried to ascertain the percentage hæmolysis with this modified arrangement, a great difficulty was encountered owing to the lag of the selenium cell. The lag was so great that the cell on being once exposed could not recover its original conductivity unless 6 to 7 hours' rest is given. Accordingly only one estimation could be made in a day, although Ponder claimed in his paper published in the proceedings of the Royal Society that estimations could be made every half an hour with an arrangement of the apparatus which, the authors noticed, failed to detect any change whatsoever in the conductivity of the selenium cell on exposure to light obtained from a four-volt lamp, although the galvanometer they used was of the order of 10⁻⁸.

26. A blood-inhabiting spirochæte of the guinea-pig.

R. KNOWLES and B. C. BASU, Calcutta.

A blood-inhabiting spirochæte of the guinea-pig, belonging to the relapsing fever group, is described. The infection is easily transmissible from one guinea-pig to another by blood inoculation. White rats and rabbits are also susceptible.

The course of the disease resembles that of avian spirochætosis in the fowl, but is much less severe, the mortality being about 31 per cent. After an incubation period of 2 to 6 days spirochætæ appear in the blood, multiply rapidly, are present for 7 to 28 days, and then disappear. The animal may die at the height of the infection, or a few days after the spirochætæ have disappeared, or may recover.

The disease is definitely febrile in the guinea-pig.

The infection does not appear to be hereditarily transmitted, nor is there any transmitted immunity. In animals which have recovered from infection there is a solid immunity.

Relapses occurred in 9 out of 69 animals.

During the height of the infection the internal viscera swarm with spirochætæ, but after the disappearance of spirochætæ from the peripheral blood no spirochætæ can be detected in emulsions of the internal viscera and these emulsions are not infective to clean animals.

The spirochæte is one typical morphologically of the relapsing fever group; with a length of from 13.5 to 23 microns thin and delicate and

with finely tapering ends. By special staining a very delicate single terminal flagellum can be demonstrated at each end. The spirochæte can be readily cultivated in Galloway's medium.

In fed *Irgas persicus* the guinea-pig spirochæte develops in a manner exactly similar to that of *Spirochæte anserina*. The vast majority of the ingested spirochætes disintegrate and die. A few however survive and divide very rapidly. Very thin and delicate *tenue* forms are produced and these pass into the hæmocele from the 3rd to the 5th day. From this they invade all the viscera of the tick. There is heavy and progressive invasion of the salivary glands, whereas the infection in the gut slowly dies out. Emulsions of the infected salivary glands of the tick are infective on inoculation into clean guinea-pigs, but the authors have been unable to cause infection by the bite of infected ticks. Presumably in Nature the transmitting vector is some species of tick which gains access to guinea-pigs.

Previous records of blood inhabiting spirochætes of rodents are discussed.

It is suggested that the name *Spirochæta cobayæ nov. sp.* be given to this organism.

The paper will be illustrated by lantern slides.

27. An entamœba of the lizard.

R. KNOWLES and B. M. DAS GUPTA, Calcutta.

A description is given of a new entamœba of the wall gecko, *Hemidactylus flaviviridis*.

To be illustrated by lantern slides, photomicrographs.

28. The coccidia of lizards.

R. KNOWLES and B. M. DAS GUPTA, Calcutta.

The coccidia of lizards have been very little studied. The paper gives an account of three species of *Eimeria* and one of *Isospora* parasitic in the wall gecko, *Hemidactylus flaviviridis*.

To be illustrated by lantern slides, photomicrographs.

29. A note on institutional tuberculosis.

M. KESAVA PAI, Madras.

The data have been obtained from an investigation held amongst 1,500 employees in a large printing press in the city of Madras. A tuberculosis survey, held during 12 months ending 30th November, 1932, revealed an incidence of 2.5% of active tuberculosis amongst the workers, the incidence being highest between 15 and 35 years, lessening after the 35th year. A further survey for another twelve months amongst the same workers, which included only persons suffering from respiratory affections and evident non-pulmonary tuberculosis, shewed that there were over 4% persons suffering from chronic pulmonary affections, of whom at least 2.5% on casual examination would have been classed as pulmonary tuberculosis, but for a very careful bacteriological and radiographic examination which revealed 1.8% of pulmonary tuberculosis, 0.75% of chronic bronchiectasis simulating pulmonary tuberculosis and 1.8% of chronic bronchitis. It appears very likely that the incidence of active tuberculosis amongst workmen is not so high as is usually supposed but that a certain percentage of these are non-tuberculous chronic pulmonary disease simulating tuberculosis.

30. A note on the influence of social and economic factors on tuberculous infection.

M. KESAVA PAI, Madras.

The paper embodies the results obtained during an investigation held in a hostel of 55 'depressed classes' students with a control series of 24 boys from an adjacent High School of the same age group but living with their parents. The hostel boys belonged to the poorest families of Southern India of the lower classes, whilst the High School boys belonged to the middle classes, the average income of the two sets of families being Rs. 16 and Rs. 40 respectively per mensem.

The hostel boys being maintained by public funds were better fed than the High School boys living with their guardians and shewed better physique than the latter. In spite of this there were 6% cases of active tuberculosis of the lungs amongst the hostel boys, 100% shewed calcified hilus glands, 48% being large and extensive in distribution and 90% shewed peribronchial fibrosis, 15% shewing very dense and extensive fibrosis. In the control batch there were no cases of active pulmonary tuberculosis, 80% only shewed calcified mediastinal glands, 32% being dense and extensive, and 80% shewed peribronchial fibrosis, 12% only being dense and extensive in distribution.

None of the 3 cases of active pulmonary tuberculosis amongst the hostel boys gave a family history of tuberculosis.

These results indicate that the poor social and economic conditions of childhood are mainly responsible not only for the abortive juvenile lesions of tuberculosis but for the later active adult lesions, the factor of infection being relatively unimportant.

31. The rationale of the Surgical treatment of tuberculosis of the lungs by Phrenic Exaeresis.

M. KESAVA PAI and K. S. SANJIVI, Madras.

Though it was originally considered that Phrenic Exaeresis benefited cases of tuberculous pulmonary basal involvement only and not apical cases, clinical experience has now decidedly proved that the diaphragmatic paralysis resulting from the phrenic exaeresis benefits cases of middle Zone and upper Zone disease as well. Besides the partial collapse of the lung substance and the rest obtained thereby, the occlusion of the blood vessels and lymphatics and discharge of toxic products from the bronchial tubes and cavities causing decrease of toxic absorption and a progressive fibrosis of the lung substance with occlusion and absorption of the foci of infiltration, there is an additional factor concerned in the healing process, namely the lessening of the traction on the lung substance and on cavities which results from the paralysis of the diaphragm, whereby the eccentric pull from the root towards the apex, the base and the outer aspects of the lung is minimized. This enables the closure of the cavities and the general fibrosing process to progress unhampered. Apical cavities collapse and heal by retraction towards the apical adhesion and basal cavities by retraction towards the diaphragmatic adhesion and the upward compression of the cavity caused by the paralyzed and raised diaphragm. Serial skiagrams of 22 cases are described demonstrating the rapid closure of cavities in the different Zones and the rapid contraction of the lung by progressive fibrosis after phrenic exaeresis.

32. The significance of the blood index, pulse and blood pressure in the clinical assessment of Pulmonary Tuberculosis.

K. S. SANJIVI and K. VENKATA RAU, Madras.

The difficulty of judging the future in cases of pulmonary tuberculosis has made phthisiologists seek in extra-pulmonary factors aids for assessing

the prognosis. Of such aids, the sedimentation rate and the leucocytic picture have been properly evaluated by many workers. The sedimentation rate and the blood index of Frimodt Möller and Barton have been studied in all new admissions in the Government Tuberculosis Hospital, since 1st January, 1934. These have been compared with two formulæ (a) which take the pulse and systolic blood pressure into account and (b) which is based on the pulse, systolic and diastolic blood pressure readings. Like the index the formulæ have indicated the prognosis correctly in about 70% cases.

33. The value of Phrenic Exaíresis in the treatment of Pulmonary Tuberculosis.

P. V. BENJAMIN, Madanapalle.

Phrenic Exaíresis operations to the number of 275 have been done at the Union Mission Tuberculosis Sanatorium up to 1st September, 1934.

An analysis of the result of the treatment in 221 patients is given. Of the 221 patients, 52 received Phrenic Exaíresis during the course of Artificial Pneumothorax treatment; of these, 34 or 65·4% were benefited, viz. 27 much improved, and 7 improved. The remaining 169 patients had the operation as the only surgical procedure because in the majority of these cases artificial pneumothorax could not be induced owing to adhesions; of these, 96 or 56·8 were benefited, viz. 1 arrested, 69 much improved and 26 improved.

Of the 221 patients operated, 144 had fever at the time of the operation; of these, 51 or 35·4% got rid of their fever after the operation.

Of the 221 patients operated, 202 had Tubercle Bacilli in the sputum at the time of the operation; in 68 or 33·7% of these Tubercle Bacilli disappeared from the sputum after operation.

34. Lung tuberculosis in children.

A. C. UKIL, Calcutta.

The paper is based on an examination of Mantoux test and X-rays and follow-up of 106 children between 0-15 years who have been in contact with 'open' or T.B. positive cases. The period of contact has been noted. Lung infiltrations have been detected in 36 cases.

35. The rôle of allergy and immunity in tuberculosis.

A. C. UKIL, Calcutta.

An attempt has been made to interpret various lesions, chiefly in tuberculosis of the lungs, among rural, semi-rural, and urban people, on the basis of allergy and immunity *vis-a-vis* infection with tubercle bacilli. The observations are based on the history of contact, close or remote, with a source of infection, the influence of urbanization or industrialization, the radiological appearances and histo-pathologic studies. The prognostic significance of these lesions has been suggested.

36. Section of thorax in diseases of the chest.

D. N. BANERJEE, Calcutta.

A method is described how section of the whole chest in different planes can be made and preserved permanently in the museum for the purpose of instructive demonstration of the topographic relationship of the normal and diseased structures.

A demonstration of several such specimens preserved in the museum will be made.

37. The applicability of Phrenic Evulsion in pulmonary tuberculosis at the Out-patients department of a city hospital.

A. C. UKIL, P. CHATTERJI, and K. N. DE, Calcutta.

The paper is based on 70 cases treated at the Chest department of the Medical College Hospital, Calcutta, during the last 3 years. The figures include two types of cases—(1) Primary or those in which A.P. failed; and (2) Secondary or those in which it was done when A.P. treatment was partially successful owing to adhesions. The results are assessed from the point of view of the ascent of the diaphragm, retrogression of the lesion, disappearance of T.B. in sputum and clinical improvement.

38. An experimental investigation into the pharmacological action of the venom of *Echis carinata*.

R. N. CHOPRA, J. S. CHOWHAN, and S. LAL, Calcutta.

The authors have been working on the poisonous snakes of India. *Echis carinata* (phoorasa) has been noticed, next to the *Indian daboia*, as one of the most poisonous vipers. This snake is found abundantly in the Punjab, N.W.F.P., Baluchistan, Rajputana, and Central India. The venom of this snake has been seen to be slow in absorption and more or less localized in action. This venom has practically no action on the *Paramædium caudatum* and other unicellular organisms even in as high concentrations as 1 in 2,000. Its action is mostly localized in lower animals as frogs, rats, and guinea-pigs. In cats it lowers the blood pressure which is due to the dilatation of the visceral blood vessels. This venom has no central action nor does it act on the heart but the action is more or less allied to histamine shock. In large doses, the respiratory and the vasomotor centres are paralyzed and finally the terminal motor and plates in all the skeletal muscles are also paralyzed as in the case of curara poison. The cause of death therefore is due to the engorgement of the splanchnic area and later on due to the failure of the respiratory mechanism. If the artificial respiration is maintained, and large doses of normal saline with vascular stimulants like adrenalin and pituitrin be perfused intravenously, life can be saved. This venom is considered to be less toxic as it is localized and slow in action, but considering the M.L.D. per kilo. and the dose injected per bite, it is as toxic as the cobra venom and more toxic than the *Indian daboia* venom.

39. Pharmacological action of *Periploca aphylla*.

R. N. CHOPRA, SARDARI LAL, and N. DE, Calcutta.

The plant is said to be a substitute for *Soma* of the Vedās and is brought from Persia to India as *Homa* of the Parsis. A glucoside was isolated from the stem of the plant which produces an initial fall in the blood pressure followed by a rise. The fall is due to the slowing of the heart and dilatation of the peripheral blood vessels. The rise produced is due to subsequent increase in the amplitude and rhythm of the heart. The tone and movements of the gastro-intestinal musculature are increased *in situ* as well as in a uterine bath. The rhythmic contractions of the spleen are accelerated. The pupils become constricted. That these actions are due to the direct action of the drug on the vagi is proved by the fact that after atropine no such effect is produced. The action of the glucoside very closely resembles that of pilocarpine on all these tissues while the seat of action also is vagal nerve endings.

40. Action of emetine on the adrenal glands.

R. N. CHOPRA, J. C. GUPTA, and A. C. ROY, Calcutta.

Bose (1931) in his experiments with albino type of Himalayan rabbits found that the injection of emetine produced a marked intensification of insulin response which he explains by the toxic effect of the drug on chromaffine system. The post-mortem findings on a fatal case of emetine poisoning showed parenchymatous degeneration of the adrenals along with anatomical changes (Leiby, 1930).

Whether emetine had an effect on the residual epinephrine content was worked out on Belgian hares after giving a number of injections of the drug intramuscularly. The assay of the epinephrine content was done by a modification of the biological method described by Elliott and by the colorimetric method as well. Our observations on a number of normal Belgian hares and on a series of hares after emetine injections showed that in the latter the epinephrine content was distinctly lower than that of the control animals by both the methods.

41. Presence of a histamine-like body in epidemic dropsy.

R. N. CHOPRA, J. C. GUPTA, and N. DE, Calcutta.

Within recent years epidemic dropsy has affected a large section of the population and a careful study of the signs and symptoms point to the fact that some sort of toxin is at work. A spore-forming proteolytic bacillus of the *vulgatus* group is commonly found in the diseased rice, which most of these patients usually take. The same bacillus occurring in the urine and stool of patients suffering from epidemic dropsy was confirmed by Acton and Chopra (1927) in a number of cases. The toxins elaborated by this organism resemble histamine, and a study of the pathology of the living, indicates a 'capillary crisis' being the most serious condition present. The increased permeability of the endothelium of the minute capillaries together with absolute lack of tone and resiliency of the distended wall favours the passage of the toxic substance in the aqueous humour. The fluid obtained from the anterior chamber of the eye of epidemic dropsy cases suffering with glaucoma was tested for the presence of histamine-like substances. Rat's uterus (non-pregnant) was utilized for the purpose and out of 13 experiments, 3 showed definite relaxation; showing thereby the presence of histamine-like substances in the aqueous humour.

42. An advanced method of recording electrical changes in tissues for pharmacological work.

R. N. CHOPRA, N. DAS, and J. C. GUPTA, Calcutta.

B. H. C. Matthews introduced a moving iron oscillograph with a valve amplifier for recording the electrical changes in nerves as well as muscles. Prior to that Adrian used a valve amplifier, in conjunction with a capillary electrometer for recording the nerve impulse. Gasser and Erlanger used Cathode ray oscillograph which is very sensitive, but is complicated, and require several excursions before it can be photographically recorded. But with the advent of recent valves of 'B' class, a new type of oscillograph has been devised in this laboratory with which it has been possible to improve and simplify the method for practically recording the electrical changes in the tissues by the application of different drugs. The change of excitability of tissue can be determined and the action current which accompany the propagation of the nerve impulse can be recorded. The variation of potential in action current is very rapid, being normally completed in a few thousands of a second.

The instrument consists of two sets of valve amplifier, the first one is resistance capacity coupled, completely screened by means of metallic sheet to avoid external interference. The second one is a 'B' class low frequency amplifier. The input of the first is connected to the tissue by means of non-polarizable electrodes silver on silverchloride. The total amplification is 50,000. The output of the first is connected to the input of the second. The amplifier is connected to the special type of oscillograph which has a moving coil. A small concave mirror which rotates on a jewel bearing axis is attached to that coil by means of a special hinge joint which is almost frictionless. A lamp with a focussing arrangement throws a line of bright light on to the oscillograph mirror, which reflects on the photo-kymograph. The movement of the spot of light is recorded on the moving photo film. The time record is also taken along with it.

It will be possible with this new apparatus to record the minute changes due to drug action on living tissues.

43. On the relation between the concentration of quinine in the blood and the parasite count.

R. N. CHOPRA, A. C. ROY, B. M. DAS GUPTA, and
S. K. GANGULI, Calcutta.

Experiments were done on monkeys infected with malarial parasites with a view to finding out if there was any correlation between the concentration of quinine in the blood and the parasite count at different intervals of time after the administration of quinine. The results so far obtained indicate that there is no direct relationship between the two. In cases of slight or moderate infection, the parasite count gradually decreased after the administration of quinine but with heavier infection, there was no diminution in the parasite count and it even increased considerably, though the concentration of quinine in the blood at different intervals of time was practically the same in both these cases.

44. Studies on the protein fractions of the blood sera of opium addicts.

R. N. CHOPRA, G. S. CHOPRA, and S. N. MUKERJEE, Calcutta.

It is now well recognized that the effect of morphine addiction is not only psychological but definitely pathological. This effect has been the subject-matter of our present investigation, so far as the physical properties and the protein changes of the blood sera of the addicts are concerned. The pH and the buffer action have been found to diminish probably due to an increased carbon dioxide tension and a diminished alkaline reserve observed by different workers. The increase of surface tension together with a decrease in the relative viscosity of these sera point to an increased fluid content. The cause of these changes in the physical properties may be traced to the protein changes in such cases as observed by us. The albumin fraction which is found to increase, may account for the increased fluid content of such sera due to the strong oncotic pressure that it exerts. The diminution in the pseudoglobulin fraction together with a dilution of the serum due to an increased inflow of the tissue fluids is responsible for the diminution in the total proteins observed in these cases. The increase in the euglobulin fraction, which is formed by the adsorption of lecithin by the pseudoglobulins may probably account for a deficiency of this compound in the nerve cells and a consequent damage to the Glogi apparatus. From this point of view a lecithin treatment for addiction and withdrawal seems to suggest itself very strongly.

45. Studies on the action of antimalarial drugs in monkey malaria.

R. N. CHOPRA, S. K. GANGULY, and M. CHAKRAVARTI,
Calcutta.

It has been found that a species of monkeys, *Silenus rhesus* is extremely susceptible to a plasmodium (*P. knowlesi*) which produces a very intense and virulent infection causing death of the animal if untreated. This animal can be infected with an extremely minute dose from another infected monkey, e.g. a total inoculation of 16,000 parasites given intravenously or subcutaneously. All phases of the schizogony cycle and gametocytes are seen in the peripheral circulation whilst the terminal phases of the infection are of terrific intensity with a parasite count of about $3\frac{1}{4}$ million per cubic millimetre. In view of such facts, these monkeys infected with this plasmodium form a very suitable medium for testing the action of antimalarial drugs. Further as the infection is intense and invariably proves fatal unless prompt treatment is given, the control infection by a remedy in such animals is a crucial test of its antimalarial value as there is no chance of a spontaneous cure. In an investigation of the effect of atabrin in this protozoon, it has been found that the destructive action of the drug on this plasmodium is exceptionally powerful but in a relapse multiplication of the parasite occurs with the same rapidity as the primary attack and causes death of the animal if prompt treatment is not given. Quinine, on the other hand, has a more lasting action and has a stronger effect in eradicating the parasite so that either the parasites disappear from the peripheral blood altogether, or if they reappear they do not multiply so rapidly as to produce death of the animal. Tebetren, which is a combination of acridine dye and quinine, possesses the qualities of both atabrin and quinine in quickly eradicating a primary infection and relapse, which it occurs, is never fatal.

46. Studies on the protein fractions of blood sera in malarial cases during and after the rigor stage.

R. N. CHOPRA, S. N. MUKERJEE, and B. SEN, Calcutta.

Protein fractions of chronic malarial cases have been observed to undergo changes in their quantities, both absolute and relative, by various workers. In the present work the authors have followed up these changes during the different stages of malaria especially during the rigor stage which is a severe and characteristic paroxysm in such cases. These have been compared with similar figures of a few malarial cases after the rigor stage is over, and also of a few normal cases. Along with this the physical properties such as the surface tension, the relative viscosity, the pH and the buffer action that are likely to be influenced by the protein changes in the serum have also been determined. Blood sera of the same individuals both during and after rigor have been studied. From the data as obtained by the authors they are led to conclude that compared with normal subjects the percentage of the total proteins in malarial blood sera diminish, due to a marked diminution in the albumin fraction. The pseudoglobulins do not change while the euglobulins are found to increase. The pH and the buffer action remain like normal while the surface tension and the relative viscosity both undergo a slight diminution. Although these changes are in the same direction both during and after the rigor stage, they are more marked during the paroxysm than after it. From this it appears likely that the changes as observed by us in malarial cases really set in during the rigor stage and reach a maximum. These changes begin to disappear and finally reach normal values within a short period after the rigor is over.

47. Malnutrition in cattle on a low mineral diet.

K. C. SEN, Muktesar.

Dairy animals require a large amount of lime and phosphorus. When deficiency of either of these occurs in the ration, the animals lose condition and their milk yield is affected. With an insufficiency of phosphorus in the diet, a condition usually associated in this country with protein deficiency also, additional disorders may be evident, such as temporary or permanent sterility, birth of weak or dead calves, bone diseases or general unthriftiness. In this paper a study has been made of the effect of phosphorus and lime deficiencies on our dairy animals, using locally grown fodders, and a general account of the results obtained are given. The possible effect of high mineral feeding on the prevalence of Johne's disease in a dairy herd is also reported.

48. The permeability of the placenta of goats to rinderpest virus.

P. C. BANERJI and R. N. MOHAN, Muktesar.

Certain substances, when introduced into the maternal circulation, may find their way to the tissues of the foetus. Amongst the various species of mammals the placenta of the domesticated animals (pig, horse, and ruminants) is said to form an effective barrier to the passage of antigens and antibodies from the mother to the foetus. The specific histological structure of the placenta and the molecular size of the antigen are the two most important factors which largely govern the permeability of the former to the latter. Judged by these conditions the goat has a relatively impermeable placenta, yet it allows a very minute antigen like the virus of rinderpest to pass through it.

49. The etiology of so-called 'Calcutta Sore' of cattle.

S. C. A. DATTA, Muktesar.

This refractory sore on the humps and neighbouring parts of cattle has been known to exist for a long time in at least three provinces, viz. Bengal, Assam, and Bihar and Orissa, having attracted the attention of several investigators. These sores have been held to serve as portals of entry for the causative organism of Bovine lymphangitis, and streptothrix organisms were incriminated as the cause. It has a peculiar season incidence with a tendency towards spontaneous healing during the winter.

From our previous experience of the pathology of certain helminthic diseases, the suspicion that a nematode worm is the etiological agent arose sometime ago, and when the publication by Bubbermann and Kraneveld on *Cascado* or *stephano-filariasis* was received, specimens of morbid tissue were asked for from the provincial veterinary authorities. Very recently the information that microfilariae have been seen in the lesions in Assam has been received, and subsequently in the researches carried out at this Institute, adult nematodes, microfilariae, and ova showing the larvæ in various stages of development have repeatedly been seen in tissues of the hump sore received from Cuttack, Calcutta, and Silchar. The histopathology of the disease, and the morphological characteristics of the nematode have been studied. The worm has been found to be different from *Stephanofilaris* sp. but the exact identity is still under study.

50. Sequelæ to Foot and Mouth disease.

S. C. A. DATTA, Muktesar.

In this article it is proposed to record certain sequelæ to Foot and Mouth disease in cattle, which have hitherto not been recorded in this country.

Among valuable imported Friesian bulls, more than one fatal outbreak of Foot and Mouth disease were encountered during the last year. Foot lesions, symptoms of distressed respiration and the finding of severe congestion of the lung or pneumonia appear to have been constant. When the initial febrile reaction to Foot and Mouth disease subsided within a week of its onset, the cattle appeared to be singularly free from malaise or to be gradually recovering, till a sudden aggravation due to complications of pyæmia or septicæmia was seen represented by either a rise of temperature or disturbed respiration, and death invariably followed a considerable time after the first symptoms of Foot and Mouth disease were seen. The interest of these cases lies in the fact that initially other affections were incriminated notably Theileriasis, Blackquarter, and Hæmorrhagic Septicæmia, until finally the real nature was revealed. It is necessary for field officers in India to keep this in mind when dealing with the above clinical syndrome in valuable imported dairy stock.

51. Encephalo-myelitis in a goat.

S. C. A. DATTA, Muktesar.

Histopathological studies upon an interesting specimen of the brain and spinal cord, obtained from a goat in the Hyderabad State, manifesting symptoms of paraplegia, have been made. From the picture seen in sections the diagnosis of *encephalo-myelitis* has been arrived at. Cases of paraplegia in the goat have been seen in this country, but since no definite data regarding them are available, the finding in the present case is worth recording.

52. A typhoid-like disease of the dog.

S. C. A. DATTA and D. A. MUNRO, Muktesar.

For elucidating some of the obscure diseases of the dog in India, a large share of the credit is due to medical authorities, notably Cristophers, Patton, Manifold, and Boyd. Information of value is available on conditions such as piroplasmoses, infection with *Salmonella aertrycke* and possibly with *B. proteus*, amoebiasis and leptospiral jaundice, but the public health aspect of these diseases has yet to be properly demonstrated. Recently another medical officer in this country has had grounds to suspect the possibility of dogs playing a rôle in the transmission of outbreaks of human typhoid fever, and no doubt a report will be published when his chain of evidence has been completed. Experimental work of Krogh and Lund (1930) has already incriminated the sledge dogs in Greenland.

Last year an outbreak of a rapidly exhausting, and generally chronic disease, associated with a fluctuating temperature of up to 104° or 106° F., slight anæmic changes, nasal discharge sometimes with traces of blood, was encountered amongst imported dogs in a kennel in the United Provinces. Occasionally, in the acute cases, diarrhoea and black fæces have been seen. Tick fever was suspected, and all possible lines of treatment were tried, but the majority of the dogs died. Materials from four of these cases were available for study, as a result of which we have now succeeded in isolating from fæcal material a pure strain of a gram-negative, motile bacterium, agglutinating in a high titre the patient's serum. Morphologically, culturally, and biochemically this organism resembles *Eberthella typhi*, but not serologically. An anti-serum from our organism is not agglutinable with paratyphoids, A, B, and C and with *E. typhi*. Pathogenicity tests on rabbits have been carried out invariably causing death in from 18 to 72 hours, but the organism is not so rapidly lethal in the guinea pig and the dog. Experimentally infected dogs have exhibited an irregular thermal reaction, resembling what has been observed in clinical cases, and further studies are in progress.

53. On the occurrence of *Stilesia vittata* (Cestoda) in ovines in India.

G. D. BHALERAO, Muktesar.

Stilesia vittata has been known in the past to be a parasite exclusively of camels. The host specificity of this cestode was so strictly adhered to that Southwell in his recently published Fauna volume refuses to believe that the parasites could have been obtained from the sheep, in spite of the fact that his informant had supplied him with the correct information. The writer has, on several occasions, obtained this parasite from ovines at Muktesar and his experience goes to show that *S. vittata* is a more common parasite of ovines in this locality than *S. globipunctata*. Like some others *S. vittata* is a common parasite of both camels and ovines in this country.

54. The common worms of sheep and goats in India and their control.

G. D. BHALERAO, Muktesar.

The article is written with a view to acquaint the lay public in India with the common worm parasites of sheep and goats, and to suggest the most practicable means for their control. At the outset is pointed out the importance of ovines and their usefulness to human beings. The parasites are dealt with under three natural groups, viz. flukes, tapeworms, and roundworms. The flukes incorporated are the three liver flukes, *Fasciola gigantica*, *F. hepatica* and *Dicrocoelium dendriticum*; three blood flukes: *Schistosoma indicum*, *S. spindalis*, and *S. bovis*, and one conical fluke, *Paramphistomum cervi*. Of the adult tapeworms *Moniezia expansa*, *M. benedeni*, *Avitellina centripunctata*, *A. lahorea*, *A. sudanea*, *Stilesia globipunctata*, and *S. vittata*, and among the larval tapeworms *Gysticercus tenuicollis*, *C. ovis*, *Coenurus cerebralis*, and *Hydatid cysts* are dealt with. The roundworms treated consist of *Ascaris lumbricoides*, *Haemonchus contortus*, *Ostertagia circumcincta*, *O. orientalis*, *Bunostomum trigonocephalum*, *B. phlebotomum*, *Oesophagostomum columbianum*, *O. venulosum*, *Dictyocaulus filaria*, *Varestrongylus pneumaticus*, and *Trichocephalus ovis*.

In each case the popular name of the worm, its life-history, symptoms caused, treatment and preventive measures are given. Description of the worms is given in an extremely popular style. In conclusion, suggestions regarding the general preventive measures for combating worm infestation are offered.

55. Immunization of horses against tetanus in tropics.

A. K. SEN, A. K. HAZRA, and S. K. BOSE, Calcutta.

- (1) Selection of horses.
- (2) Production of toxins and toxoids.
- (3) Immunization :
 - (a) with toxins,
 - (b) with toxoids, and
 - (c) with toxins or toxoids along with non-specific stimuli, viz. :
 1. Alum,
 2. Tapioca, and
 3. Calcium Chloride.
- (4) Conclusions.

56. The etiology of enzootic bovine hæmaturia.

S. C. A. DATTA, Muktesar.

In the etiological researches upon hæmaturia, data of considerable value and promise were referred to in the Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for 1931-1932 (p. 15), and the possibility of the peculiar rounded macrophage-like cells, provided with occasional blunt and short projections, being entamoeba were mentioned in the Report of 1932-33 (p. 15). The examination of samples of urine from clinical cases here at Muktesar and the study of histopathological sections from several cases have at last revealed the nature of these foreign bodies of etiological significance to be a protozoan amœboid organism of the phylum *Rhizopoda*, resembling to a great extent *Entamoeba histolytica*. From the characters of the parasite it appears that it may be a new species. Intensive work on experimental transmission, treatment with amœbicidal drugs and cultural studies are in hand, and it is hoped that the hitherto obscure problems of this serious scourge, which has been known in most countries of the world for a very long time, will be finally solved within a short time.

57. Relation between heights and weights of Bengali women.

G. C. NANDI, J. DHAR, S. SEN, and P. C. MAHALANOBIS,
Calcutta.

Records of height, weight, parity, caste, civil status, and economic class were obtained for about 2,700 women attending the Calcutta Exhibition in 1933. The relation between height and weight for different age groups has been investigated in detail by the method of skew correlation analysis.

58. A statistical method of testing the genuineness of a sample of ghee.

P. C. MAHALANOBIS and K. C. RAY, Calcutta.

Constants of genuine cow and buffalo ghee, published by Bengal Public Health Department, have been analyzed statistically in this paper. Mean standard deviation, coefficient of variation of the four constants (Reichert Woolly value, Saponification value, Refraction Reading, and Iodine value) have been calculated together with their probable errors and the correlation co-efficient between every pair of constants have been obtained. The statistical parameters for buffalo and cow ghees have been compared and an attempt has been made to find out a statistical test of adulteration from the observed constants.

59. A statistical analysis of hospital records of some delivery cases in Calcutta.

P. C. DAS, N. K. RAY CHAUDHURY, and P. C. MAHALANOBIS,
Calcutta.

Records of 200 delivery cases have been analyzed with regard to distances between A.S.S. and between Iliac Crests, measurements of External and True Conjugates and the weight of Fœtus. It has been found that there is practically no correlation of the age of the mother with any of these measurements. The correlations between any two of the measurements taken are significant and in some cases, very high. For example, the correlation of distance between A.S.S. with that between the Iliac Crest is $+.85 (\pm .026)$.

60. A statistical note on certain hæmatological studies of fifty new-born.

P. C. MAHALANOBIS, Calcutta.

J. Dhar has recently published (*Indian Journal of Pediatrics*, Vol. 1, July, 1934) certain valuable hæmatological studies of 50 new-born. The object of the present note is to draw attention to the results which may be obtained by the application of the method of analysis of variance and correlational analysis to such studies.

61. A preliminary study of the Ayurvedic and Unani specifics for anæmia.

H. B. SREERANGACHAR, Bangalore.

Reputed preparations have been analyzed for their inorganic constituents. All of them are characterized by a predominating proportion of iron while a few have been found to contain mercury, arsenic, and sulphur. It appears rather strange that none of the preparations so far analyzed contain any copper, especially in view of the recent work of Josephs (*Bull. John Hopkins Hosp.*, 1931, 19, 246); and Parsons *et al* (*Arch. dis. child.*, 1933, 8, 85) who find that copper is essential for the rapid and complete cure of anæmia. The exact form in which iron occurs in these different preparations and gets assimilated is being studied.

62. Waves of rhythmic contractions and relaxations in the perfusion tracings of the blood vessels of frog *Rana Tigrina* with special reference to the action of adrenaline, ergotoxine, pituitrin, barium chloride, Janus green, and ephedrine.

S. A. RAHMAN and R. N. ABHYANKAR,
Hyderabad (Deccan).

A method is described by which the recording system becomes highly sensitive to the changes of pressure in the perfusion fluid.

In some of the experiments the perfusion fluid was made to enter the left systemic arch and, after having passed through the vascular system, was allowed to escape through a cut at the apex of the ventricle. In the other experiments the posterior extremities alone were perfused, the fluid entering the abdominal aorta and, after passing through the vessels of the legs, escaping through the anterior abdominal vein. In both the cases the perfusion pressure tracings showed a wavy character.

On the face of it, the waves seem to be caused by the rhythmic contractions and relaxations of the blood vessels of the frog. But other influences, such as movements of the viscera, are also discussed as possible factors in causing the waves, or in modifying their character. These points are still under investigation.

Adrenaline tends to obliterate the waves; ergotoxine, barium chloride, and ephedrine exaggerate the waves, whereas pituitrin and Janus green have no effect on them. The nature of the action of some of these drugs is also discussed.

63. Studies on the normal arsenic content of Indian foodstuffs.

K. N. BAGCHI and A. C. BOSE, Patna.

The determination of normal arsenic content of various food materials is likely to be of medico-legal importance. Chapman found in one sample of prawns no less than 1.2 grains of arsenic, calculated as As_2O_3 , per pound (*Analyst*, 1926, 51, 554). This discovery has changed the whole

outlook of medico-legal analysis and complicated the problem of finding out arsenic in stomach contents of a suspected case of arsenic poisoning and of interpreting the result of the findings.

Attempts have been made in this investigation to estimate the quantity of arsenic, if present, in our foodstuffs. The method employed is mainly of Ramberg for destruction of organic matter and of Marsh-Berzelius for final estimation—both the processes have been modified by Chapman. There was considerable difficulty in obtaining the right quality of arsenic-free Zinc. Some of the samples of Merck's and Kahlbaum's Zinc were not absolutely arsenic-free as stated on the label and in some the typical brown mirror of arsenic could not be obtained.

Twenty different articles of food (wet substance) were examined. Some of them gave the following result:—

Sea-fish, obtained from Puri	..	0.05	grain per lb.
Hilsa fish	0.035	„ „
Rohit fish	0.004	„ „
Lobster	0.025	„ „
Goat's flesh	0.004	„ „
Goat's liver	0.0046	„ „
Beef	0.007	„ „
Beef-liver	0.018	„ „
Chicken	(a trace).	
Mahua flower	0.0042	„ „
Rice, Wheat, Dals, Potato, and green vegetables—a trace.			

So far, the samples of Sea-fish have given the largest amount of arsenic and the vegetables the least. This paper is a preliminary note and further investigation is in progress.

64. A note on the use of saccharin as a sweetening agent from the point of view of public health.

B. M. GUPTA, Lucknow.

Since the accidental discovery of the excessive sweetness of ortho-benzoncsulphinide, commercially known as saccharin, by Fahlberg at Johns Hopkins University, U.S.A., about 1879, it has been widely used as a sweetening agent. It is also used medicinally in diabetes, in liver disease, and in cases where the use of sugar is undesirable. A warning has, however, been issued against an indiscriminate use of saccharin as it may give rise to the predisposition to the epithelioma known as Pitch and Sweep's cancer (*B.M.J.*, 15, ii, 553). This view is not shared by many authorities. It is, however, generally held that the physiological action of saccharin is not negligible, as it decreases appetite, gastric secretion, peptic digestion, and intestinal absorption.

In this country the vast majority of the consumers are not aware of the fact that saccharin is extensively used as a sweetening agent in lemonades and other sweet drinks. At the present state of our knowledge, the total prohibition of the use of saccharin will be too drastic. It is, however, suggested that—

- (a) the sale of articles containing saccharin may be brought under control;
- and (b) the local Food and Drug Authorities may frame regulations compelling the manufacturers using saccharin to declare it explicitly on the labels.

65. A plea for vitagraphic assay of ghee.

B. N. BANERJEE, Bangalore.

Lately physical methods for the vitamin A assay have been developed to an extent and data collected to justify the same for estimating the

growth-promoting factor of butter and *ghee*. It has many advantages over the usual biological method and is superior in this that the most important item, the growth-promoting fraction, is determined. If the 328 μ absorption band is determined together with a colorimetric or spectroscopic determination for carotin, the vitamin A content can be accurately determined in a butter or *ghee* sample. Such an assay is better than the usual chemical analysis, and is a necessity, nowadays, when hydrogenated oils and fats are freely used for the adulteration of *ghee*. Should it be mixed with cod-liver oil or halibut oil, it is not difficult to detect. The Hilgers have put in a cheap Vitagraph on the market, and results of analysis by this method on *ghee* and butter are found to be satisfactory.

66. Studies on the physiological function of renoflavin (Vitamin B₂?).

N. DAS and B. C. GUHA, Calcutta.

Experiments have been carried out on the oxidation of amino-acids *in vitro* by different tissues of the rat, both normal and Vitamin B₂-deficient, in and without the presence of renoflavin, a flavin obtained from ox-kidney. The results indicate that the flavin has some function in the respiratory processes.

67. Chemical studies on oxytocin.

N. DAS and B. C. GUHA, Calcutta.

Work has been continued on the chemistry of oxytocin, the oxytocic principle of the pituitary gland. The action of various reagents like nitrous acid, nitric acid, and hydrogen peroxide and of solvents like pyridine, alcohol, acetone, and chloroform has been investigated.

68. Dry lymph.

K. P. MENON and M. OMAR SAHIB, Guindy.

This paper records the findings of a few experiments conducted on dry lymph both from cow calf and buffalo calf. Otten in Java obtained good results with dry lymph after storage at room temperature over two years; whereas in this case, the dry lymph did not show any activity after two months' storage at room temperature. The authors have used Otten's technique of preparation. The only difference was that they used calves for their tests, whereas Otten's tests were on human children.

Among the samples of lymphs collected at 72 hours, 96 hours, and 120 hours, the first two did not show any superiority in point of potency over the lymph collected at 120 hours, and if at all the last was a shade superior.

69. Normal blood pressure standards for Indian adults.

D. V. S. REDDY, Vizagapatam.

Paucity of reliable standards for Indian adults. Method and material. Tabular summary: average systolic=114.5; average diastolic=72.8. Comparison with European and American figures reveals the author's averages to be 10 to 15 mm. lower. Agreement with readings from Philippines, China and Porto Rico.

Text-books give tables and formulæ suggesting that systolic goes on steadily increasing with every advancing year. The work of Sorapure, Smyth, Alvarez, etc. confirms that from 19 onwards to 40 years there is no evidence of any change in pressure. Systolic reaches maximum between 19 and 22 and the diastolic between 21 to 24 years of age. Then the systolic and diastolic keep level till 40 years.

Regarding lower average pressures in the Tropical races, many explanations given. Effect of diet and habits of life recognized, though difficult to speak quantitatively. Racial differences considered. Investigations eliminating effect of environment (records of b.p. of different races living in England and America).

Influence of climate. Oliver points out that spell of hot weather lowers systolic by 10-20 mm. Dr. Frank thinks that warm atlantic air currents effect a lowering of b.p. due to electrical disturbances. Musgrave and Sison opine that greater vasodilatation in the Tropics leads to lower blood pressures. Experimental study of the effects of exposure to higher temperatures upon circulation in man led Adolph and Fulton to conclude that dilatation of peripheral blood vessels and the rise of skin temperature play important part in reducing peripheral resistance. Diathermy and U.V. rays are also known to reduce the b.p.

Foster and also Roddis and Cooper from a study of records of occidental whose b.p. was recorded first in the temperate climes and then in Tropics believe that there is usually a fall of 10 to 15 mm. as a result of stay in the Tropics.

Lemmann, on the other hand, thinks that climate has no effect at all. Records of b.p. of white men in Philippines reveal no significant fall.

Discussion of the relative importance of each factor in India.

70. Comfort standards in the tropics.

D. V. S. REDDY, Vizagapatam.

Temperature recorded with dry or even wet bulb thermometers is not an accurate index of human comfort which depends on the cooling power of the environment. Kata thermometer introduced and perfected by L. Hill is an excellent guide to the cooling power of any atmosphere, to which the human body, dry or sweating, is exposed. Many investigations have been done in Britain and America to determine the actual as contrasted with the ideal conditions for work of various types. Reports of similar investigations in India are scanty though the subject of human comfort in the College, Office or Factory is of paramount importance to the social worker as well as to the medical man.

Following the lead of Vernon kata thermometer readings were recorded in different situations at different hours in all kinds of weather at Vizagapatam (latitude 17.42° N. and longitude 82.2° E.). The minimum, maximum, and average cooling power for daytime for different calendar months are given. Sensations of air movements (on a scale of 5 grades) are compared with the cooling power of air and velocity of air (obtained by Hill's and Vernon's formulæ). A correlation of records of personal sensations of comfort (on a scale of five like that of Winslow) with the cooling power of air during summer and winter seem to confirm Vernon's view that there is a factor of 'acclimatisation', both racial and climatic, and that the minimum cooling power of 6 (suggested by Hill) is not necessary at moderately high temperatures (70°F.). The present series of readings record personal sensations of comfort described as 'pleasant', 'cool and refreshing'; nice weather was recorded under the following conditions:—

Temperature Range	24-27°C.	28-31°C.	32-35°C.
Cooling power	5.5	5	4.2

The ideal cooling power desirable and easily attainable in Vizagapatam appears to be in the vicinity of 4.75 in summer and 5.25 in winter. But even with a cooling power of 2.4 in summer and 3.2 in winter no actual discomfort, stuffiness, etc. was felt by persons working in loose cotton garments and these figures may be regarded as the irreducible standard for South Indian buildings.

71. The extent and intensity of extreme ultra-violet solar radiation at Calcutta. with special reference to its therapeutic value.

P. N. GHOSH, A. C. UKIL, and M. K. SEN, Calcutta.

Ultra-violet solar radiation at Calcutta has been investigated with special reference to its extent and intensity. The different methods of determination of intensity have been discussed. The spectro-photometric method has been used in our experiments. The continuous radiation from a hydrogen discharge tube with quartz end plates has been selected as a standard source of radiation. The plate has also been calibrated so far as its sensitiveness and contrast in different wavelength regions are concerned. Such a standard discharge tube is now available in the important research laboratories of the world. The investigation indicates that in a day, both the extent and the intensity attain the maximum value from noon to 2 P.M. while the evening and morning have comparatively low values. June has been found the month in which the intensity attains its maximum, especially after a brisk shower of rain when the atmosphere is free from suspended impurities.

The diurnal and seasonal variations have been graphically represented in terms of the new unit proposed by us and will be demonstrated.

72. The derivation of suitable mathematical expressions to account quantitatively for the adsorption of antigens by anti-bodies or *vice versa*.

B. N. GHOSH, Calcutta.

Ehrlich, Arrhenius, Madsen, and others believed that the neutralization of antigens by anti-bodies is a process of chemical combination and hence follows the laws of classical chemistry such as the laws of constant composition, of mass action, etc. On the other hand according to Bordet, Biltz, and others antigens are adsorbed on the surface of anti-bodies or *vice versa* and thereby rendered ineffective, i.e. neutralized. One of the main difference of the two points of view is that according to the latter the law of constant composition is not applicable to the substance formed by the union of antigen with the corresponding anti-body. Bordet and others of his way of thinking believed that the composition of the antigen-anti-body complex varies with the relative proportions of the antigen and anti-body present in the reacting system. It has not yet been settled satisfactorily as to which of the two theories are in better agreement with facts. Starting with the assumption that on the surface of an anti-body or antigen particle as the case may be there are a number of active groups (which may be called receptors' adopting Ehrlich's nomenclature) where a particle of the corresponding anti-substance can be adsorbed an equation has been derived by the author which accounts satisfactorily for the observations of Arrhenius, Madsen, and others. If α be the number of cubic centimeters of an anti-body solution be added of T units of the corresponding antigen then the equation takes the form—

$$(\alpha N - P)(T - P) = KP,$$

where N is the maximum number of units of antigen which 1 c.c. of the anti-body solution can adsorb and hence neutralize; P is the number of units of antigen actually adsorbed under the conditions of the experiment and K is a constant. Solving the equation we get—

$$P = \frac{(\alpha N + T + K) - \sqrt{(\alpha N + T + K)^2 - 4\alpha NT}}{2}.$$

Hence the amount of antigen adsorbed can be calculated from the above equation provided N and K which are constants for a given sample of

anti-body and antigen are evaluated first. This can easily be done from two sets of experimental observations. The equation has been found to account satisfactorily for combination of Tetanolysin, cobra hæmolysin, crotalolysin, diphtheria toxin, ricin, rennet with their corresponding antibodies. In fact this equation which is based on the hypothesis of adsorption accounts satisfactorily for all the observations which were considered by Arrhenius and others as convincing evidence in favour of their theory.

73. *Leishmania* vaccines.

J. C. RAY, Kasauli.

The use of protozoal vaccine for treatment has seldom been tried. Though serious doubts still exist in some minds regarding the feasibility of the production of effective protozoal vaccine, the author is firmly persuaded to believe as a result of several years' investigation that the defence mechanism in the host's body reacts in infections due to *Leishmania* in the same manner as in bacterial infections.

The oriental sore vaccine, prepared from freshly isolated strains of *Leishmania tropica*, was tried on a large number of patients suffering from oriental sore and has been found to possess high value as an agent for treatment. In cases where sores were situated on the eyelids, nose, lips, and forehead and in sores with septic ulceration, where administration of Berberine sulphate was not possible and carbon dioxide snow treatment would have resulted in extensive formation of scar, the treatment with vaccine proved of high value. The author has been able to produce luxuriant growth of the parasites on a special medium, thus making the preparation of the vaccines on a manufacturing scale at a low cost.

Leishmania vaccine prepared from the freshly isolated strains of *Leishmania donovani* was tried on a limited number of patients suffering from post-kala-azar dermal Leishmaniasis. Even the patients suffering from severe and intractable forms of lesions have shown marked improvement under the vaccine treatment.

74. Studies on 14 cases of rhinosporidial infection.

M. N. DE and J. BANERJEE, Calcutta.

Although the pathological anatomy of rhinosporidium infection is well-known, there are certain features which have not yet been observed.

There is a super-added acute and sub-acute inflammatory reaction both in the sporangia, as well as in the tissues outside. The nett result of such an inflammatory process appears to be the formation of a dense cicatricial tissue and spontaneous healing. During the intermediate stages, large multinucleated foreign body giant cells are found in abundance, particularly around the disintegrating cellulose capsule of the sporangia.

The character of the above pathological changes will be illustrated with lantern slides.

75. Cutaneous manifestations of epidemic dropsy.

M. N. DE and K. D. CHATTERJEE, Calcutta.

These changes are mainly confined to the adipose tissues of the subcutaneous layer and consist of a marked telangiectatic condition of the capillary blood vessels. This phenomenon gives rise to the characteristic reddish flush and the solid œdema which is one of the prominent features of the disease. In some cases there develop many brawny, inelastic nodules on the surface of the skin. These are composed of a mass of granulomatous tissue with very marked capillary dilatations. Sometimes, these nodules may give rise to a profuse hæmorrhage. Unlike

an inflammatory swelling, they are not tender or painful. No micro-organisms could be detected in these nodules and inoculation experiments into rabbits and guinea-pigs did not reveal any characteristic reaction.

These nodules, if left to themselves, disappear completely during convalescence, leaving only a pigmented scar, but they are liable to re-appear if there is a relapse of the primary disease. The bigger sized nodules can be surgically removed completely without any additional risk of hæmorrhage. The characters of the nodules and their pathology will be illustrated by lantern slides.

76. Bengal splenomagaly.

M. N. DE and K. D. CHATTERJEE, Calcutta.

These are cases of enlarged spleen and liver with secondary type of anæmia and running a very chronic course. The patients usually suffer from an irregular pyrexia not reacting to the known specific remedies against malaria and Kala-Azar. They usually lead a chronic invalid life and ultimately develop a portal type of cirrhosis of the liver with hæmatemesis, melæna, ascitis, and jaundice. Complications, such as ulcerative colitis, cancerum oris, pneumonia, and tuberculosis may set in during the late stage of the illness and carry off the patient. Blood picture is not characteristic. Such cases are found plentifully in many districts of Bengal endemically, although some cases are also reported from other parts of India and Ceylon. They have not been found to be associated with Leishmaniasis or Malaria, and their true etiology is still an open question. This splenomegalic condition, whatever may be its cause, constitutes one of the main factors in the incidence of hepatic cirrhosis in Bengal. Splenectomy has been found, by the writers, to be a successful mode of treatment.

The pathology of the disease and the results of splenectomy will be illustrated by lantern slides.

77. Relation of diets to diseases, with special reference to tuberculosis and leprosy.

N. K. BASU, Calcutta.

The idea that the defects in the diets are primarily responsible for the production of diseases is fast gaining ground. Recent discoveries of the dietary essential factors, vitamins, are also lending great support to this view. In the paper, experimental evidences have been adduced to show how such defects in the diets can produce tuberculosis and leprosy, and how by correction of these defects spread of these diseases can be prevented.

78. A study of Steinach rejuvenation operation of patients for a period of three years.

J. E. DHUNJIBHOY, Kanke.

The author read a paper entitled 'Conquest of Senility by the Steinach and Voronoff methods in selected cases' at the Indian Science Congress held at Patna in 1933. In this second paper he is giving a full account of his three years' study on cases with Steinach rejuvenation operations together with a short history of rejuvenation and technique of the Steinach method.

79. Thrombo-angiitis Obliterans of Buerger.

J. F. ROBINSON, Mysore.

The present concept of this disease is that of a fairly constant pathologic picture and a fairly constant clinical syndrome. It is a disease

of arteries and veins, affecting the vessels of the lower limbs usually. It is characterized by low grade inflammatory changes in the vessel walls with thrombosis in the lumen and much prevascular fibrosis, involving the neighbouring nerves, producing pain. It takes a progressive course which may culminate in gangrene of the affected extremity. The vessels of the other limb may be involved subsequently, sometimes after the lapse of several years. Occasionally both lower or even all four extremities are affected simultaneously. The disease tends to be recurrent. The age incidence is usually from 20-40, hence it is termed 'pre-senile' gangrene. Almost invariably it affects males and has a predilection for young, asthenic, nervous individuals. The disease was formerly thought to be limited to Jews of Polish and Russian origin, but it is now recognised in Americans, Chinese, Japanese, and Europeans. The cause of the disease is not known. Syphilis is not a factor. A French writer recovered an organism from a recent thrombus and injected it into the ear vein of a rabbit, causing the disease in the ear vessels and leg of the animal. Another French observer views the disease as a new morbid entity due to a specific organism spreading insidiously throughout the world.

The symptoms noted are paroxysmal cramping pains (intermittent claudication) even after gentle exercise, coldness, blueness, or oedema of the extremities and the occurrence of painful, superficial gangrenous ulcers about the nails. Pulsation in the *dorsalis pedis* artery of one or both sides is absent. Mummification of the toes appears or a torpid subungual suppuration which is mistaken for an ingrowing toenail and operated upon with disastrous results.

Diagnosis is difficult. Syphilis and Diabetes are to be excluded. Heavy cigarette smoking is a factor in some cases, though cases occur which never used tobacco. But if tobacco was a factor in the first attack and smoking to excess is resumed after recovery from the attack, it may help in precipitating a subsequent attack. The history of ischaemia in the extremities (lower) in young men, an absence of *dorsalis pedis* artery pulsation and cramps in the calf or foot muscles after only moderate exercise are suggestive.

Treatment consists in trying to decrease the viscosity of the blood in order to help the circulation through the narrowed vessels by administration of excessive amounts of Lock's solution transduodenally, the intravenous use of hypertonic saline (500 c.c. of 5% solution), protein shock with intravenous doses of triple-typhoid vaccine in ascending doses (from 10,000,000 to 500,000,000 killed organisms), locally applied heat by electric bulb cradle, local injection of anaesthetic solutions and the latest suggestion of Rabinowitz which seems the only treatment required—the intravenous injection, on alternate days, of activated sulphur. Reference is made to numerous other suggested treatments and a few typical and atypical case histories are included.

80. The subcutaneous injections of pure oil of *Hydnocarpus Wightiana* in the treatment of Leprosy.

TALEC, MONGLOND, and DAMODARIN, Pondichery.

The therapeutic effects of Chaulmoogra oil, used in the treatment of leprosy, depend upon the variety of the oil used and the way the same is assimilated by lepers.

This is the thing that explains the non-concordant results obtained by experimenters with various oils and the different pharmaceutical preparations with Chaulmoogra oil.

The experimentation of all these products, tried in all the French Colonies, has not yet solved the delicate problem of the Chaulmoogric therapeutics and we are still brought to make hypotheses on the active principle of those oils: greasy acids or phytosterine in the envelopes of the seed.

Under these circumstances we think that the most rational therapeutics are those which consist in giving pure oil of *Chaulmoogra*, extracted by cold expression from the *Hydnocarpus* seeds, and which contains certainly the active principle.

The disadvantage of these therapeutic preparations comes from the acidity of the oil used which would make the injections painful. Out of the therapeutic results on which it is still too soon to decide, the object of this communication aims at proving :

(1) That the sub-cutaneous and intra-muscular injections of *Hydnocarpus Wightiana* oil of weak acidity are painless :

(2) And to ascertain when pure oil of *Hydnocarpus Wightiana* becomes painful by injections of oil, the acidity of it increases progressively.

Thirty patients have been treated up to now by sub-cutaneous injections of pure oil of *Hydnocarpus Wightiana* of progressively increasing acidity varying from 2% to 4.75% of oleic acid.

All these injections have been perfectly tolerated and have never given rise to any accident. Fifteen of these patients have already received 18 injections of 5 c.c. twice a week, the fifteen others 12 injections.

Ten patients are treated by intra-muscular way.

The experiments are being made to find the limit of tolerance that can rapidly be obtained.

81. The pure oil of *Hydnocarpus Wightiana* Blume given by the buccal route in the treatment of Leprosy.

BOUILLAT and TALEC, Pondicherry.

It is now known that the *Chaulmoogra* oils are the most efficacious for treatment against leprosy.

The oil of *Hydnocarpus Wightiana* Blume, specially, is right : very much appreciated by those who study leprosy.

As various phenomena of intolerance, such as diarrhoea, *squeamishness*, vomiting, loss of appetite have often been attributed to the acidity of the oil, we wanted to make some trials in giving *Hydnocarpus Wightiana* oil of weak acidity.

The oil used was apportioned in a dose of 2 and 3 grammes only of oleic acid per cent. On the other hand, we thought that a pharmaceutical form of giving easily *Chaulmoogra* oil ought to be looked for in order that the ingestion of a greater quantity may be allowed in trying to realize an essentially physical action, due to which the greasy substance would be found divided into small little drops uniformly distributed in the midst of a liquid.

The formula used is as follows :

Pure <i>Hydnocarpus Wightiana</i> (Weak acidity)	100 grammes
Powder of gum arabic 60 ..
Ordinary syrup 200 ..
Lixiviation of roast coffee (sufficient quantity for 1,000 grammes.	

20 c.c. of this medicine contain two grammes of *Hydnocarpus Wightiana* Blume, one gramme corresponding to 39 drops counted with a normal dropper, the temperature being 30° Centigrade.

The trials have been made on 14 lepers who had joined hospital. It results from these tests that it is possible to make the patient take under the form of oily 'loch' and by doses divided into fractions large quantities of pure *Hydnocarpus Wightiana* oil of an acidity of 2 to 3 per cent. It seems, on the other hand, possible to give, without difficulty, 400 to 500 drops per day of such an oil and progressively come to 30 to 40 grammes (1170 to 1560 drops per day) and to more than 2,000 drops to a patient, before remarking appreciable signs of intolerance.

New tests are to be made with oil of progressively increasing acidity.

82. Etiology of Calcutta Cerebrospinal Fever of 1934.

B. B. SEN, J. NAHA, S. C. BHATTACHERJEE, and S. C. ACHERJEE,
Calcutta.

Altogether 135 samples of Cerebrospinal fluid from Meningitis cases during the Calcutta Epidemic of 1934 were studied. Infective organisms were identified and classified. 6·8% Streptococcus, 22·9% Pneumococcus, 1·8% Influenza Bacillus, 24·5% Meningococcus Pure, 3·4% Streptococcus and Meningococcus Combined and 40·6% Gram Negative Diplococcus of peculiar type were isolated. Treatment of Meningococcus Meningitis by Antimeningococcus Serum was found generally to have given satisfactory results when adequate quantities of Serum have been administered. Classification of fatal cases has laid us to conclude that the cases with double infection are the most dangerous ones. Cases of Pneumococcus origin die before proper diagnosis. Virulence of the new type of organism is very high. Some of the peculiarities of the new organism have been described.

83. Variation of some of the physico-chemical and colloidal properties of egg-albumin, hæmoglobin and blood on the addition of some common medicinal preparations.

MOHINI MOHAN BISWAS, Calcutta.

The Ph specific conductivity, viscosity, and stability of egg-albumin, hæmoglobin and blood have been measured by adding gradually increasing concentrations of some alkaloids, electrolytes, non-electrolytes, and some colloidal preparations. The observations have been discussed in relation to the therapeutic properties of these systems.

84. Diet in relation to diseases, with special reference to Tuberculosis and Leprosy.

N. K. BASU, Calcutta.

A preliminary discussion of the effect of faulty nutrition on the production of diseases in general has been made. The result of a study of the effect of deficiency of vitamins A, B, C, and D on Tuberculosis by mortality in infected guineapigs and that of vitamin B on a number of early cases of Leprosy has been described. It is concluded that in Tuberculosis the deficiency of vitamin A is connected with the loss of integrity of epithelial tissue; that of vitamin B with anorexia and gradual loss of weight, that of vitamin C with diminished tissue resistance and that calcification of foci is helped by vitamin D and that in Leprosy vitamin B improves the anaesthetic patches (with return of sensation of skin) more satisfactorily than the cases of nodular type and that the earlier the case the quicker the response.

85. Modern survey in Tuberculosis.

S. M. MAZUMDAR, Calcutta.

The importance of properly conducted Tuberculosis Survey on modern lines in establishing the co-relationship between the etiological factors and the actual disease process has been pointed out. An attempt on similar lines has recently been made by Dr. Ukil with the help of the

Tuberculosis Association of Bengal. That there is considerable alteration in the actual disease process as influenced, modified or aggravated, with the variations in the environmental, social, and economic factors has been shown by a preliminary investigation amongst a group of people of more or less the same occupation by repeated Home Visits, X-ray findings, Sedimentation rate, and other laboratory methods as well as by clinical examination. The exact lines of work undertaken have been shown by means of a number of information cards.

Section of Psychology.

President :—DR. SUHRIT CHANDRA MITRA, M.A. (Cal.),
D.Phil. (Leipzig).

Presidential Address.

PSYCHOLOGY AND LIFE.

LADIES AND GENTLEMEN,

Like every other science, the science of psychology starts with certain assumptions and works under certain limitations. Whether these assumptions are metaphysically tenable or morally justifiable, it is not at present the direct concern of scientific psychology to enquire into. If not anything else, it is a methodological necessity not to do so. Rightly or wrongly, there is a tendency in many intellectual centres, especially perhaps in this land of ours, to decline to give serious consideration to any proposition that does not bear the mark of some one or other of the recognized philosophical schools, or is not amenable to the process of measurement by some one or other of the accepted ethical standards. The tendency is certainly not healthy for the development of any science. No one who has attentively studied the history of psychology could have failed to notice that it was this tendency, coupled with an inability of many authors to look dispassionately at mental processes and operations that was the main reason why the emergence of psychology into the field of natural sciences was so unnaturally delayed. It needs time and practice to be true to one's own self and it is certainly not easy to take up an objective attitude towards the processes of mind. To avoid this difficult task some authors have chosen the more alluring path of creating an elaborate tissue of facts suited to the prevailing ideas, temperaments and moral standards of the time, rather than building up a system of psychological thinking on facts minutely observed, critically studied and logically integrated.

Though laborious, the latter, however, still remains the method which science pursues and the former path we gladly leave to be followed by those who have plenty of leisure at their disposal and a hobby for intellectual pastimes. The first task of all science, therefore, is the observation and collection of facts. But there are disputes as to what precisely should be meant by a 'fact'; and there is every prospect at present of these discussions being continued to the end of time. Science therefore has to break away from them at a certain point and start its own activities. The point at which it breaks away is

the assumption that it makes. The subject matter of individual sciences decides in each case this point of secession.

This necessity of making assumptions before starting leads automatically to certain limitations in the field of enquiry of every science, and in the method pursued by each. What then are those facts and principles which the science of Psychology takes for granted at the beginning of its career? I shall here enumerate only those which have a direct bearing on the subject of my present thesis. The first relevant point is that there exists in this universe a type of phenomena known as mental phenomena and that there is another similarly existing type of facts known as physical phenomena. Among the physical phenomena there are some which are characterized as having life as distinguished from others which do not possess this attribute. It is another assumption of psychology that these mental phenomena, which are the special objects of its study, are intimately connected with those which have been described as the living physical phenomena. I am fully aware that all these assumptions may be challenged and indeed they have been attacked from various sides. The existence of a special type of phenomena, called mental for example, has been denied by the radical Behaviourists and the physical phenomena have been sought to be argued away into mere shadows or illusions. Further, even when the existence of both is granted the exact nature of the relation between the two has been a matter of acute theoretical controversy. I would fain have left all these controversies aside in order to achieve the main purpose of my paper which is essentially a practical one. But lest I be misunderstood and be accused of vagueness as regards my position with respect to these basic questions of psychology, let me mention at once that I am radically opposed to the Behaviourists who consider it their duty to free the language from the burden of all words and phrases which seem to convey the barest suggestion of a something called mind. I need not delay here in putting forth arguments which I have done elsewhere. I would only say to the Behaviourists once more along with Dr. Prince, 'Godspeed to you. Go as far as you can go; but you are bound to come up against a stone wall somewhere, sometime, and you have finally got to come to conscious experience'.¹ As to the philosophical argument, it may safely be passed over for the present; for the acceptance of it at the beginning of any study immediately brings it to an end. Not only psychology, but physics, chemistry and all other natural sciences would be mere stupendous follies if all that we experience around us is a huge camouflage or a magnificent mirage which may crumble any moment at the slightest touch of the magician's wand. Or perhaps we may meet the argument in another way.* Even assuming that nothing that we see around us and touch and hear and feel, does really exist at all, the fact

remains that we do experience the illusion of their real existence. And it is precisely these facts of our experience that are the sole concern of all science. So looking from this angle science cannot be robbed of its subject matter by philosophy. Whether the worlds, physical and mental, have an ontological existence or not, science does stand and so psychology remains. Then again, as to the question of the relation between the physical and the psychical, parallelism seems to me to be the most logical and consistent view to hold, when the two types are recognised to be fundamentally different from each other. For the simple reason that this is the best working hypothesis and for the reason that no one else has been able to suggest any better, I am inclined to think that psychophysical parallelism should form at present one of the corner stones of scientific psychology. I am further convinced that we shall not be landed in any morass when the theory is extended to beings other than the human and even beyond them to forms of creations which are devoid of life. However, that does not concern us now.

The existence of psychical phenomena as distinguished from the physical being assented to, the next assumption is that it is these psychical phenomena which are primarily the objects of psychological investigations and that such investigations are to be carried on on the psychological plane. I have observed in another connection and I repeat here that I fully believe in a future possibility of interpreting all mental functions and processes in the terminology suited to its own proper sphere and not borrowed from that of any other order of things or any other field of science. Besides some conceptions which are universally applicable to all sciences, there will develop in the near future a category of terms peculiar to psychology alone which will be the safest and most dependable medium for carrying on psychological researches and which will be able to render full and thorough explanations of all mental states, processes and functions. That would not mean of course, that psychology would necessarily reject any help towards the understanding of the psychical processes that may be advanced by other sciences, but what should be remembered is that all such explanations would be indirect ones and would more or less partake of the nature of analogy only. At the present time, let it be freely confessed that there are many facts in our psychical experience for a fuller interpretation of which we have to depend mainly if not wholly on physiology, biology and other allied sciences.

The psychical phenomena which are the subject matter of psychological enquiry are not however to be considered in their generalized abstract forms but primarily as they are concretely manifested through the behaviours of individual living beings. And the start is always to be made with the study of human beings. Thus we have at last reached the real problem

of psychology in its broadest outlines. We realize that the task of psychology is to study the workings of the mind as manifested through the behaviours of the living human beings. A further set of, shall I say postulates, should I think be mentioned here. Let it be granted that the world is peopled throughout with living human beings and that each of them experiences within him or her a series of mental phenomena, the sum total of all of which may be described as his or her mind. Let it be further granted that the mind of one such being in this sense may differ from that of another in many respects as the behaviours of two of them under the same circumstances are never exactly alike. Let it be also granted that along with the bodily development of a child into a man or a woman there is a corresponding mental development from infancy to adulthood. The word development is here used of course without any implication of 'betterment' but only in the sense of progress as it has been defined by Myers, viz. 'change making for increased differentiation of function, increased co-ordination of parts and increased integration of previously independent parts'.² I do not think that any one of these statements need to be proved.

After all these axioms and all these postulates, we can now turn perhaps to the actual propositions. That the world is peopled with living human beings carries with it an implication which also must be taken for granted, viz. that the human beings do not live all by themselves but that they live in families and societies, where there is division of labour as also mutual co-operation, where certain customs prevail and traditions persist, where law and order reign and certain norms of conduct keep watch over all private and public activities. If the reality of this order of things be accepted as fact, then for practical psychology the first proposition would be that life is after all worth living. For otherwise the majority of the people would have agreed to a joint suicide and thus have brought that which was not worth maintaining to an end. The minority of persons who renounces the world and chooses to live in wildernesses or those who prefer the solitary enjoyment of the beauties of nature rather than the pleasures of communal life are very interesting objects of psychological study if they are at all amenable to it. But I will not venture to say whether they could have been reclaimed for society by a proper psychological treatment of their mental life or a judicious selection of their social environment. There have been persons however, who have carried the spirit of renunciation to the most extreme degree possible and have deliberately ended their lives. It is with regard to these unfortunate victims of social maladjustments that the psychologist makes bold to say that many of these lives could surely have been spared and spared greatly to the benefit of the society itself.

Here I come right at the centre of my theme. For I have

not used the word 'life' merely in the narrow biological sense of adjustment to physical environments. By life I here mean particularly the mental lives of individual persons as influenced by the society in which they find themselves. Let us remember that the implications of the word society are many and of diverse kinds and that forms of culture, religion, tradition, economic condition, etc. are all suggested by it. The demands made on an individual living in a society therefore are of various natures and they are of different grades of extensiveness and intensiveness; and the healthiness or otherwise of his life depends on how far he is able to meet them. This, then, the problem of how to adjust one's self to the social conditions of life or to make the social conditions suitable to one's own self, is the crucial problem and on the ability to offer useful solutions of this problem depends the success of psychology as a practical science.

For, after all, does not the idea conveyed by the term 'maladjustment' stand at the root of all conceptions of disease, physical or mental? The living body is an organism, by which is meant that all organs and all parts are interdependent, and the function of the whole depends on a proper adjustment being maintained between them. Statistically considered the exceptionally high stature of a man may be designated as abnormal, but that by itself does not constitute a disease. It turns out to be so only when this abnormal growth in height has been gained at the cost of the development of some other organ or organs, i.e. when the proper adjustment between the different sets of organs has been violated. Similarly in the case of mental maladies. Society does not simply mean a collection of individuals. It also is an organism where all individuals composing it are mutually interdependent and no one can thrive at the expense of the others. A trait in a person's character may be designated as abnormal judging by the small frequency of its appearance in a large number of men but it need not be termed a diseased trait simply on that account. It readily becomes so however, whenever the presence of it leads its possessor to actions by which the harmonious working together of all other individuals, i.e. the adjustment on which the life of the society depends, is threatened to be disrupted. Society does not tolerate such acts of violence to itself and speedily devises means to counteract all such destructive activities. Taunts and sneers directed towards such persons are a measure of social defence and may be effective in some cases and if they are not, more rigorous means might be adopted for which society need not always be blamed. Preservation of the harmony is the goal of all man's striving and the effort to maintain it is the spring of all his every-day actions. For these reasons, I consider that the definition of disease given by Dr. Bose is the most accurate and logical one from the theoretical

standpoint as it has also proved to be the most fruitful in the practical field. He defines disease 'as an abnormal and an anti-social trait'³ and by an abnormal trait he means a trait whose deviation from the average is greater than the standard deviation of the group to which the individual belongs. The conception of abnormality thus varies not only from group to group but also from age to age.

Incidentally, and as it is in harmony with the topic that I am developing at present, I would like to put down here some of the very valuable suggestions that he once made to me during the course of an informal discussion on defects and diseases. He emphasized the 'anti-social' character of diseases generally and regretted that this had not been sufficiently worked out as yet in medical literature though a little search would provide illustrations as plentiful as blackberries. The method of dealing with abnormalities, when by accident or for reasons not yet discovered, they happen to be present in rather a large body of persons, varies in different societies and history shows that only those societies have flourished and continued to live which found, let us call it, the social method of treating them. For example, everyone agrees that Hermaphroditism is an abnormality and is present in almost every society perhaps in much larger numbers than is usually imagined. But a society which refuses to tolerate them and imposes restricting legislations regarding them only weakens itself; because by forcefully shutting out these victims of circumstances for traits for which they themselves are certainly not responsible, a society creates dissensions among its own members and invites the hatred and antagonism of a large section of its own populace. The net result of this turns out to be the loss of that adjustment which is the essence of a living society. But in some societies, as *e.g.* in our Hindu society, all these dissensions and consequent tension of feelings have been avoided by a very simple but at the same time highly ingenuous method, viz. by giving these unfortunates a distinct social status. They have been made to feel that though abnormal they have certainly some function to fulfil in the service of society and this at once removes the sting from their grievances. Being assured of a safe and somewhat responsible place in society they do not feel themselves compelled to wage war against it, as similarly deformed persons have to do in other lands. Witness, *e.g.* the efforts of Miss Radcliffe Hall in her book 'The Well of Loneliness' or the attempts in some other countries to obtain legal sanctions for acts of homosexuality. Now these hermaphrodites cannot be at once cured of their disturbing hereditary defects by means of medicine, neither can they be all on a sudden removed from the face of the earth by mere magic or murdered all together by acts of legislation. Therefore, however paradoxical it may sound, the only effective way of dealing with

them and of preserving society against them lies in taking them within its fold and by an amœboid movement absorbing them into it.

A large number of abnormal persons has been integrated into social groups by the simple device of providing for them an appropriate social atmosphere as is to be found in the different religious sects. The religious practices of these sects are often very queer but because of the fact that they have a social sanction behind them a good deal of individual mental struggle is avoided. The operations of the herd instinct in providing mental equilibrium are to be seen in these so-called abnormal groups. This fact should serve as a warning to reformers who aim at a summary revolution of the entire social fabric.

Following a similar trend of thought one can easily understand that an idea becomes a false one only when it cannot be assimilated with other ideas that have already co-ordinated themselves and formed a system. Such an unintegrated idea is a superstition with reference to the already existing system. But a superstition cannot be removed simply by pointing out the finger of scorn to the person or nation supposed to have it. The only method of dealing with it is the psychological method which starts with a ready assent to the superstitious idea but gradually works up and out of it. One must know why a superstition originates and what individual demands it satisfies before one could cure it. Children have too many wrong notions in their heads and possess quite a number of superstitious beliefs but to wipe out all such absurdities from their minds, mere dogmatic assertion of statements contrary to their cherished ideas and beliefs will avail absolutely nothing however often they might be repeated. It is for this reason that it has been said that one has got to be a child with the children. It has been repeated many times in theory but unfortunately forgotten an equal number of times in practice.

To bring about a better adjustment between the individual and the society, the disturbance of which causes much personal suffering and a good deal of social unrest, there are three ways left open. It can be done by changes introduced in the environment, by modifications wrought in the psychical constitution of the person or by a combination of both these methods. The remedies suggested by psychology are not however wonder-working miracles like those medicines so much advertised in the daily papers and 'guaranteed to cure all ills whatever within a few hours of being taken otherwise money to be refunded'. To suggest psychological remedies, investigations into the material conditions of the cases as also psychological analysis of the human elements involved are the first prerequisites and both these steps of the procedure need time. Hence it would be demanding too much from psychology when she is asked, as she has sometimes been asked, to prove her mettle by

freeing the society of all evils immediately and at a single stroke.

In some cases at least it is too late in the day to enquire about the ability of psychology to render help to make things brighter and to lessen the difficulties of adjustment. Industry and commerce happen to be two of the major occupations of all nations of the present century and as such they cannot fail to influence the lives of not only those who are actually and actively engaged in such pursuits, but through the environments that they create, also of those who are outside the pale of such organizations. Here is a field in which psychology has already demonstrated how by proper arrangement of physical conditions and psychological handling of the human factors it is possible to confer larger benefits to the producer as also greater comforts to the workers. I need only mention to you the psychological organization called The National Institute of Industrial Research established in Great Britain with correspondent members throughout the Empire. A study of the periodical bulletins issued by it and the brochures occasionally published under its auspices reveals the enormous amount of research work in this field that is being conducted under the able guidance of Dr. C. Myers, formerly professor of psychology in the University of Cambridge. It testifies also to the immensely useful service that has been rendered by the institute both to the capitalists as well as to the labourers and through them indirectly to the society at large. The need for such organizations has been felt in every country and almost every country which is in cultural contact with ours has started such or a similar institute. But in this unfortunate land of ours, in this vast subcontinent, where there is no dearth of factories and workshop, railways, corporations and such other organizations employing a large number of men, has any such institute been started anywhere? There has not been as yet. I do not think that it is superfluous for me to dwell at some length on this particular topic though a strong plea for organizing such an institute was made last year at Bombay by Mr. M. N. Banerjee, my predecessor in the honoured post which you have asked me to fill this year. To my knowledge, he is the first worker in this field in India who has made some attempts, as a chosen representative of the psychology department of the University of Calcutta to undertake some preliminary investigations in at least two of the large and well-known factories of Bengal and Behar, viz. The Bengal Chemical and Pharmaceutical Works in Manicktolla, Calcutta, and the Tata Iron and Steel Works at Jamshedpur, Tatanagar. The magnitude of the task is vast and the problems needing attention in this field are numerous. Little can be accomplished without the co-operation of not merely many psychologists, but also of others, *e.g.* technical experts, the managements, statisticians, etc. not

to speak of the labourers themselves. Increased output with shorter hours of work is certainly a coveted achievement in any big factory. It is, however, not a myth nor a fairy tale but such a desired result has been actually obtained under the guidance of psychological experts in many houses of industry in Europe and America. And there seems to be no assignable theoretical reason why such a state of things cannot be produced and maintained here. Strikes and lockouts are more often than not a result of bad management which brings about the gradual collapse of that spirit of co-operation which ultimately is the rock upon which any organization where many people have to work together must rest. The personality of those entrusted with the task of making men work together is an important factor and should always be given weighty consideration. This may sound as a commonplace observation to make but be it stated that it is modern psychology that has found means for the proper selection of such personalities. The method of selection is of course not perfect as yet and certainly there is need for its improvement ; but the programme has been laid and it may very well be hoped that the time is not far off when in the free and civilized countries of the world, different posts requiring different capacities will be filled by just the proper set of persons certified by the psychologists as possessing the required abilities. And these certificates given by the psychologists will not depend on their whims or idiosyncracies but will be based on objective tests from which the personal factor of the examiner will be as far as possible eliminated. These tests, vocational tests, as they are called, are now in great demand everywhere. They are a crying necessity here too, but I am afraid that the sad spectacle that is witnessed here in abundance of M.Sc., B.L.s earning their livelihood by doing petty clerical jobs, or of people of no calibre whatsoever holding high executive appointments, of skilled artists compelled to hide their talents in the dusty archives of a mercantile firm, of the legal profession being filled to overflowing by wits, half-wits and no-wits even, of teaching being the last refuge of the despondent unemployed, the sad spectacle of these and of others too numerous to mention cannot be removed by the application of the vocational tests alone. The application of such tests presupposes that a certain degree of efficiency is desired and therefore they are of no avail where efficiency is not a prime consideration.

In the sphere of commerce as also in all other spheres wherever propaganda and advertisement are essential, psychology is certainly the most important single factor to be taken into account. How to design posters, for example, or to draw pictures that will surely attract the attention of those for whom they are meant and immediately appeal to their hearts, are problems that only a correct understanding of the psychology

of those concerned can solve. Businessmen who do not care to keep themselves acquainted with the changes in the sentiments of their customers cannot thrive in their business, nor can the modistes or manufacturers who fail to note the direction in which fashion's wind is blowing. Effective salesmanship is based on the knowledge of the preferences and tendencies of the customers and on the ability to work up to that knowledge.

It has been very rightly suggested that one of the surest ways of making the immediate future state of society free from the ugly defects of the present lies in a better conducted plan and well-thought-out system of education. And it is a very hopeful sign of the times that everywhere in India, not only educational authorities but all responsible and thoughtful persons, have been applying themselves wholeheartedly to this onerous task of reforming educational methods. That the situation and environment of the day when the current scheme of education was conceived have changed to-day beyond recognition is a historical fact and it is readily intelligible that the old system if pursued now would not be of much use to the modern youths in the task of adjusting themselves to their environment. I may be permitted perhaps to point out with some pride one remarkable achievement that has already been accomplished by the Calcutta University. The introduction of vernacular as a medium of instruction in high schools even has been a step, as you can easily understand, of very great psychological importance. I have no doubt that as a result of the deliberations of the various committees and sub-committees which have been appointed by the University, a better system of education, more suitable to the modern conditions of life in our country, will emerge which will help to stem the tide of disappointment and distrust that has overtaken our youths and to root out from their hearts the source of all mad and reckless activities.

Let it however be brought home to all concerned that however ideal a school curriculum may be from the theoretical standpoint it may not be possible for every boy and girl to go through the course prescribed. It is sheer waste of energy to attempt to force down the same matter in the same way through the throats of all. The time and the effort of the student unfit for such a curriculum but compelled to undertake same are entirely lost. Such a student when he grows up becomes merely a burden to society, whereas the chances are that had he been given proper facilities for developing his own innate aptitudes which did not perhaps lie in the line of the prescribed course, he might have been one of the most useful members of it. It is in connection with this problem that the Intelligence Tests perfected by the psychologists are of the greatest use. In other countries periodical tests of the intelligence of every

student have become a regular feature of all school work and in some countries college freshmen even are subjected to tests with a view to helping them with suggestions as to the courses best fitted for them. I should mention, that in India too some work in this direction has been done. Dr. Rice and Mr. Banerji have translated the Terman Tests into Hindusthani and Bengali respectively, and attempts to form suitable questionnaires and to determine norms of Bengali children have been made and are still being made by Mr. H. P. Maiti and Mr. G. Pal, both of our department in the University here, the former of whom was elected President of the Psychology section of the Philosophical Conference which has just concluded its deliberations at Waltair.

I would like to suggest here that the preparation of standardized sets of intelligence tests, suitable to the different provinces of India be at once undertaken by the respective universities and the labours of the different universities in this direction be co-ordinated through the medium of the Inter-University Board. The determination of norms is no doubt a task beset with difficulties but they are not insurmountable ones. As regards the University of Calcutta, I think, the already existing Board called the Students' Health Welfare Committee may be enlarged by the addition of psychologists and recognized teachers whose duties it will be to collect psychological statistics along with other information regarding the physical health of the students. When these statistics have been collected they may be sifted and analyzed and out of them the norms may be prepared. An alternative proposal to this I have made towards the end of my address.

But psychologically considered, school education is already a late step in the matter of education which really begins from the moment a child is born. It is now beyond dispute that some of the roots of all maladjustments of later life are invariably laid in the pre-school periods of infancy and childhood. The most beneficial service that has been rendered to humanity by psychoanalysis is certainly the crystal clear revelation which it has made of the contents of the infant's mind. It is easy to accuse psychoanalysts of sex mania but it is difficult to remain uninfluenced by the discoveries of Freud and his associates. Judging by the increasing amount of references made to Freud's theories, not always appreciative though, in the text-books of psychology and in various other spheres of scientific work where Freud had assiduously and relentlessly pushed forth his investigations, time is not distant when he will be regarded as a harbinger of a new epoch in the history of science as Darwin had been in the middle of the 19th century.

The educational significance of Freud's researches lies specially in the theory which he has propounded regarding the development of the sex life of the infant and the interplay of

the emotions of love and hatred towards their parents. The existence of the Oedipus complex warns us to be cautious regarding our own behaviour before children and to be extremely careful as to our personal dealings with them. The discovery of the unconscious and the realization of its immense influence in guiding the course of mental development have placed a heavy load of responsibility on the shoulders of the parents and the teachers who can continue to ignore it only at great peril to themselves and risk to society. Fixation at any point of development during childhood is disastrous for the future mental balance of the individual. The intellect may be impaired and the will have recourse to unusual channels to express itself. The entire outlook of the individual may be radically changed so that he will feel himself out of touch with his neighbour but at the same time will not have the ability to adjust himself to the latter's world. His neighbour in his turn will naturally dub him as eccentric. Beginning from such slight eccentricities of temperaments where the divergence from the normal is but slight, there is a whole gradation of mental maladies up to the most extreme forms where the divergence is absolute and complete. It is very much to be regretted that while the number of such mentally afflicted persons is steadily going up in our country, the attempt to grapple with this growing evil is limited as yet only to a few persons. There is no active effort in the medical colleges of India to keep abreast of the modern researches in this field of pathology and to interest the students in the vast changes that have been introduced in the methods of psychiatry. The tendency unfortunately is still too strong in families to withhold even from their physicians all information regarding such afflicted members. A similar hush hush policy is often adopted in case of that fell disease Tuberculosis. In both cases the result is dangerous, firstly because much suffering could certainly have been alleviated and perhaps a life could have been spared by early treatment and secondly because the blot, if it be considered as such, which might have been erased out if exposed to the view of the physician, continues to taint the whole family, the present members as also all future ones. The worries, anxieties and troubles caused to the members of a family where there is a mentally diseased patient are really very great and such patients are a continuous strain on the nerves of all who have to keep watch over them.

Psychoanalysts maintain that a large number of such cases are curable and what is more, many of them are quite preventible. The sudden outbreak of the symptoms is not the beginning of the disease. It has been brewing for a long time inasmuch as a conflict was going on in the mind of the patient between his repressed asocial desires and the standards of conduct which he consciously accepts. It is not necessary

for me to give any theoretical exposition of the principles and processes of psychoanalysis but it is entirely relevant to my purpose to demonstrate how it has proved to be of great service and benefit to us in the various walks of life.

In the first place, it has given us an entirely new outlook of the nature of the mental processes and the laws of their working. The gaps which were deliberately passed over by the traditional psychologists, as if they did not exist, have been filled by materials derived from the study of the unconscious and a continuity has thus been established. The immense significance of the unconscious for every aspect of a man's life, his trend of thoughts, his manners of speech, his ways of doing things and of conducting himself in society has been brought home to us. Thus a mighty weapon has been placed in our hands which enables us to unravel the mysteries that were hidden so long in the secret chambers of the mind. This may be considered as a purely theoretical achievement. On the practical side the first and the foremost to be mentioned is the revolution that it has brought about in the sphere of children's education. I do not claim of course that an ideal state of environment has been created where all children will henceforth grow up like the beautiful lilies devoid of any blemish or of the least flaw in their character. What I do claim is that the new materials that have been unearthed regarding children's minds, if utilized scientifically to form the foundations of their education, are sure to produce a better state of affairs and thereby inaugurate a happier state of society. By happier state I mean, a state where people in general will find it less difficult to accept the ideas and to conform to the ideals that are agreed to for the time being by the majority of men as worthy ideas and desirable ideals.

In the next place, it has given us a new interpretation of the maladies of mind and by revealing the mechanism by which many of these are brought about, it has increased our power of combating these growing evils of the present time and to decrease the number of their occurrence in future.

In the third place, the clearer understanding which has been obtained about the motives of men which prompt their actions in society will, in time when the knowledge is far more widespread than it is now, surely incline one and all to take a more charitable or lenient view of the defects of others and thus help to remove a large portion of the discontents brought about by civilization.

The recognition that the blooming of love in your bosom as also the birth of hatred and the blossoming of the rose in your garden as also the growth of the thistles are equally determined natural events will induce one to be more patient with the shortcomings of the dullards, the defectives and the delinquents. It should prompt one to devise means for the amelioration of

the conditions which bring about such deformities rather than to introduce harsher methods of punishing these depraved, as criminals.

In the wider sphere of international relations the psycho-analytical principles will sooner or later have a determining influence in the shaping of events. For psychoanalysis gives us a truer understanding of the cultures of the different nations which is always the first step necessary in any work of mutual co-operation. Racial prejudice which is the greatest barrier of the present century to an appreciation of the other nation's point of view receives a better analysis and the anthropological researches relating to the various castes and tribes, a fuller interpretation when dealt with by the psychoanalytic procedure.

It is in the more intimate circle of family life that the results of psychoanalytical findings may be immediately left. It may be said at once that nothing is so destructive of domestic peace as mutual hatred. The problem of tackling with such hatred would have been easier if the latter appeared always in its own natural garb. But what has been made patent by psychoanalysis is this that often the apparently well-meaning behaviours of relatives whom you have no reason for suspecting are disguised manifestations of latent hatred. Psychoanalysis teaches us to keep watch over our own words and deeds and to look carefully and critically through our own behaviours with our fellowmen in order to be sure that the motives which we consciously ascribe to them are indeed the real motives. Analysis of our daily activities, our slips of tongue and misplacing of words, our forgetting of names and mislaying of objects, our dreams and our phantasies, our fears and our anxieties, will give a clearer insight into our own selves than anything else will ever do. In one word, if to know one's own self be the acme of wisdom psychoanalysis does certainly lay down the road to such knowledge.

I cannot resist here the temptation of giving expression to a growing belief in me that even many cases of actual physical illness may be due to disturbances in the psychical personality of the patient. Starting from the fundamental principles of psychoanalysis it is not difficult to arrive theoretically at such a conclusion by a process of logical reasoning. But a belief without the corroboration of facts is either a superstition or a mere speculation. It is however a matter of very great satisfaction to learn that such a hypothesis has already been formed by one eminent and recognized authority in the field of medicine. I refer to Dr. Smith Ely Jelliffe, M.D., Ph.D. He says, 'As yet, it is premature to say how much of the pathological (sick) disturbance in an organ's functioning can be attributed to the economic maladjustment of repressed and regressive libido operating at the organ level, but it can be

abundantly proved that such disturbances are operating. Further research by the psychoanalytic method will clarify our formulations.' ⁴ He then goes on to illustrate his views by referring to some actual physical illnesses, e.g. affections of the respiratory sphere, of the digestive tract, of the heart, etc. I cannot help quoting the very hopeful lines in which he concludes his article. 'The medicine of the future will occupy itself more and more with more accurate evaluations of the effects upon the human body of aggressive, hostile impulses and with methods of bringing them to consciousness and thereby saving mankind from many crippling and devastating chronic diseases psychoanalysis is the first scientific entering wedge bringing the dynamics of such human and social factors to the clear light of conscious evaluation.' ⁵

I have endeavoured in this paper of mine to demonstrate how psychological researches that are being conducted in the various laboratories of the world as also carried on in different hospitals, asylums and other institutions may render invaluable help to every man and woman in the struggle that each has to face in his or her mortal existence. The psychological difficulty of familial and social adjustment is no less an acute problem to-day than the economic one. A normal and healthy mind is a necessary and presumed unit in all questions of adjustment and it is the task of practical psychology to see that the units are really what they should be. If some of the units are found wanting psychology should suggest remedies in order that they may make up their deficiencies or if they are beyond the pale of such treatment it would be its duty to draw the attention of all concerned to their special cases and to improvise situations and environments suitable to their mental equipment. It might be argued that if such state of things had been remedied before without the help of psychology, if hysterics had been cured ere this by blows and obsessional cases by exorcists, there is no need of supplanting the time-honoured methods of treatment and of introducing complexities which if they do not do anything worse would at least make a greater demand on the money and the time of those who are concerned. If the system of canes and rods has been able to produce great men before the onset of the modern century there is no need to change this method of education for a costlier one of doubtful benefit. Such arguments are not unimaginable but their fallacy lies too much on the surface to need elaborate refutation. The whole science of modern medicine together with that of Homœopathy, Ayurveda and other systems should on this argument be relegated to the heap of useless superfluities as people used to get rid of their diseases before any of the above systems was discovered and practised. The most effective answer to such arguments would of course be the presentation of the records of actual results that have been obtained by the application

of psychological findings. I have however deliberately refrained from burdening my paper with masses of statistical information which after all are not difficult to be obtained by any one interested in them. Besides, it may safely be questioned as to whether hysterics were ever cured by kicks only or the 'ghosts' were driven out of the bodies of the 'possessed' by the incantations of the priests and exorcists.

In the next place while the argument that the modern psychological methods are of a costlier nature than before may unfortunately be true, the opposition that the utilities derived from them are of a doubtful nature must be pronounced to be wholly unjustifiable after all the facts that I have placed before you. As regards the pecuniary point of view, thoughtful consideration will assuredly convince any one that a little more money spent on a more beneficial and a more humane method of treatment is certainly not an extravagant expenditure for in the long run this apparently more expensive method will really turn out to be the cheaper one.

I have spoken about the benefits that are to be derived from the application of psychological and psychoanalytical principles to the problems of life. It is my duty to warn everybody against the dangers that may result from their misuse. It has unfortunately become the practice of certain sections of the community to invoke the teachings of psychoanalysis as a justification for all their deliberate misdeeds. Many current stories and novels, I hesitate to call them literary pieces, profusely illustrate the abuses to which psychoanalysis may be subjected to; they are magnificently rich in the manifestations of the terribly poor ideas that their authors possess on the subject. New ideas of morality and of social conduct, novel theories of art and beauty are sought to be propounded, all based on the misconception of psychoanalytical premises. It would not have been of any harm to leave all such puerile frivolities of the ignorant unnoticed, if they did not unfortunately carry with them a strong suggestive influence and thus powerfully affect the ideas and behaviours of the impressionable young men and women. It is however foolish to lay the blame for all such abuses at the door of psychoanalysis itself as it is invariably done by laymen and popular critics. When a sharp weapon is placed in the hands of a child or a fool nothing but disaster can be expected and it would be the fault not of the sharpness of the weapon itself but of him who allowed the child or the fool to handle it. The real antidote to the poison that is spreading through the filtration of 'little knowledge' into the wider and wider circle of non-technical men is the broadcasting of truer and more accurate knowledge of the subject. It is certain that by virtue of the tremendous significance of psychoanalysis for the life of man it will not remain confined to the physicians and experts only but is bound to find its way into societies at

large. And it is certainly to be desired that it does so. But it should be the duty of prime importance of every one empowered to deal officially with psychoanalysis to see that only right kinds of ideas are circulated about it and to combat vigorously any false impressions that may be gaining currency. It is only in this way that the purity as also the utility of the science can be preserved.

I have throughout kept a thoroughly practical object in view and I shall now close this address of mine with a few concrete suggestions as to how psychological researches may be made fruitful even in this land of ours. To begin with, the first thing that is necessary is a thorough overhauling of the syllabuses in psychology that are prescribed in the different universities. Place should be found in them for as many useful aspects of the science as possible and as much attention should be bestowed on the theoretical side of the teaching as on the practical experiments in the laboratories. On the theoretical side I am convinced that, among other things, there is enough justification for introducing courses of lectures on ancient Indian systems of psychology with special emphasis on the Sankhya and Yoga systems. I may mention that we have already undertaken the task of revising our own syllabus. It is not possible to make arrangement for teaching all aspects of the science in every university. What branch will be emphasized in any university will depend to a certain extent on the needs of the province in which the university is situated and on the particular environmental conditions. I would request the Inter-University Board to appoint a committee of experts with the express object of co-ordinating the psychological studies of the different universities. Let the committee visit the different university centres, study the facilities that are provided in them for particular types of work as also their cultural, industrial and other material circumstances, consult the departmental teachers and then make suitable recommendations keeping in view the scope and standard of psychological training in other countries as also the actual conditions obtaining in our country.

But even then the course will be more of a theoretical nature than anything else. No university, I am afraid, can undertake more than that. For this reason, my next suggestion is that an institute be created to be called the Institute of Applied Psychology financed by the university, the corporation, the Industries department of the government and lastly by subscriptions raised from its members. Its governing board should consist of representatives of the industrial and commercial interests, of the corporation, of the government and of the public, but above all of the psychologists from the university. The institute should have a thoroughly equipped laboratory of its own and its primary duty would be to undertake actual large-scale work for the benefit of the society. There should be

different departments each undertaking special kinds of work, e.g. one may concern itself with the mental tests of school children, another with vocational selection and guidance, a third with education of difficult and defective children, a fourth with problems arising in factories and in connection with different industries and so on. Intensive research on new lines and fresh problems should be constantly carried on and in order that the workers in the institute may keep themselves well posted with the nature of work going on in other parts of the world, an up-to-date library consisting of relevant books, periodicals and journals should form an essential part of it. If an institute as is outlined here be started I would advocate that every *bona fide* student of psychology, besides attending to his regular courses in the university should be compelled to put in some concrete work in at least one of these departments of the institute before he becomes entitled to a degree from the university. Such an institute should have a teaching course of its own spread over a number of years, after duly completing which and passing some tests a student may be granted a diploma. Possession of a degree in psychology will be considered as a *sine qua non* of registering for such a regular course of study in the institute. I have made the last suggestion having particularly the conditions of Bengal in view; because not being conversant with the actual state of the teaching of psychology in many other universities I am not competent to speak for them. This state of things should not have been so but I am here constrained to admit that though existing for the last nine years the Indian Psychological Association has failed to elicit that amount of co-operation amongst the psychologists of the different universities which was one of the main objects of its foundation. The blame may certainly be laid to some extent to the shortcomings of its present secretary as an office bearer, but in spite of appearing immodest I would venture to suggest that that does not wholly account for the present plight of the Association. But I do not despair. I am quite confident that if the suggestions that I have put forward are accepted and worked upon the Association would automatically revive itself and when a more energetic secretary is placed at the helm of its affairs it will soon make itself felt not only within the borders of India but also outside them.

It has been said that a healthy man does not know that he has a liver but it is only when the latter is out of function and causes pain that one comes to realize its existence. Similarly the desperate attempts that are made on all sides now for adjustments testify to the fact that the pre-existing adjustments which worked so smoothly up till now have been disturbed. The reason why psychology is primarily thought of in this connection is that the late war has fundamentally revolutionized man's view of man and completely turned his

angle of vision with respect to all established institutions. The prevailing traditions, customs, ideas of morality and even of religion which were formerly held to have a sacredness about them and were considered immutable because of their heavenly origin were rudely realized to have no such divine element in them, neither any property of immutability. They could be scattered to the four winds without the least compunction and brutally sacrificed at the altar of the demon in man. They had no sacred objective existence outside, but were mere subjective creations born out of the wishes and impulses of men. Attention was thus forcibly drawn to the workings of the mind and their subtle but powerfully acting influence in directing not only the every-day actions of the individual but also the events of society and even the course of civilization was clearly perceived. Men became conscious of the fact that it was the wishes and desires of men that lay at the basis of all human activities. New adjustments of actions, therefore, must be preceded by the adjustment of wishes. Hence it is that any serious attempt at the present time to bring about reform in any direction invariably leads back to the fundamental questions of psychology. Every one now is looking askance at psychology. Let our psychologists therefore rise grandly to the occasion, as they can if they only will, and stretch forth their helping hands to the thousands of the mentally sick, depraved and deranged that are lying scattered on all sides shunned as pariahs by the medical profession and rendered outcasts by social prejudice. Let them create in the heart of those that are healthy in body and normal in mind a desire for another order of events and a better state of society and show how such wishes can be fulfilled. To the unwary let them point out the pitfalls on the way that are to be avoided. Let them redeem those who will but who cannot free themselves from the bondage of their passions and obsessions and reclaim those who have lost all interest in life. It is only by these and such other tasks that the mission of modern psychology will be fulfilled.

I sincerely thank you therefore, ladies and gentlemen, for the honour that you have conferred on me by electing me to preside over the psychology section this year and thereby recognizing me as an humble worker in such an urgently needed cause and such an utterly humane mission.

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Section of Psychology

Abstracts

1. The fatigue-indicator.

M. N. BANERJI and R. GHOSH, Calcutta.

A series of experiments has been performed to measure fatigue in college students. Thirty University students participated as subjects. Vernier Chronoscope was used to measure R.T. for seen movements. The output of work done in each case was determined and the difference in R.T. before and after the work was calculated. The Big-muscle Ergograph devised by Dr. G. Bose was used.

2. Opposite fantasies in the release of repression.

G. BOSE, Calcutta.

Suitable fantasies of opposite types often release repression in psychoneuroses. The artificial induction of the see-saw phenomenon, resulting in the removal of symptoms and the resolution of conflicts are the chief features of this method. By identification both the repressed and the repressing wishes are realized and the malady is cured. This paper illustrates the method with a case-history

3. The teaching of English in Bengal.

GURUBANDHU BHATTACHARYYA, Dacca.

In order that the teaching of English in Bengal may be effective and placed on a sound basis children must master the fundamentals of grammar and the basic skill of reading and understanding through their mother-tongue at the early and middle stages of instruction. The New Methods of teaching English are very helpful in raising the standard of work in this subject, but nothing appreciable appears possible of achievement until the customary type of teaching English in the upper classes as encouraged by the Calcutta Matriculation Examination is reformed.

Grammar and Translation are the two objectionable features of the Calcutta Matriculation and sufficient stress is not laid on questions set to test the right type of composition.

The paper details certain practical suggestions for improving the methods of teaching English in school classes and reforming the system of examination. The writer is of the opinion that the standard of English work may be sufficiently raised with the vernacular being used as the medium of instruction and examination only if these reforms are carried out.

4. Intelligence tests in Bengal.

A. K. DATTA, Dacca.

Experiments in adapting Intelligence Tests for the use of Bengali children and adults have been in progress at the Dacca Teachers' College since the year 1921. The results of experiments on the Stanford-Binet-Simon Scale, the Non-language Tests, Columbia College Entrance Test, Bengali Group Test, Northumberland Test I, and the Absurdity Test are reported in this paper.

All English and American tests require a great deal of adaptation for use in Bengal,—so much that in most cases the results of the tests applied

to Bengalees would not be comparable with English or American results. Great difficulty was experienced in adapting and using the Intelligence Tests for children owing to the difficulty of discovering the true age. Adult tests are likely to be very useful as a means for selecting candidates for admission to technical and professional colleges. Such tests will naturally tend to be of a partially 'vocational' nature.

5. The English knowledge of non-English knowing Bengali boys.

A. K. DATTA, B. K. DHAR, and D. N. NANDY, Dacca.

The aim of this investigation was to find the number of English words that are known to Bengali children (ages 6-10) who had not yet begun to study English. About 350 words were selected, those words being chosen that seemed most likely to be familiar to the children. The children were tested individually with this list. One hundred and sixty-eight words were found to be known to 50% or more of the children.

6. The English knowledge of non-English knowing Bengali adults.

A. K. DATTA, D. C. BHATTACHARYYA, and S. N. CHATTERJEE, Dacca.

The aim of this investigation was to find the number of English words that are known to non-English knowing Bengali adults, free from town influence. A somewhat different list of words was used for this investigation.

One hundred and sixty-two words were found to be known to 50% or more of the people.

7. Reading interests of school children.

A. K. DATTA, C. L. MUKERJEE, and M. C. CHAKRAVARTY, Dacca.

Eight stories from the best child story writers were compiled into a booklet and about one thousand boys of the High schools of the city of Dacca were tested. The stories were: (1) a simple fairy tale, (2) a fairy tale of a complex type, (3) an animal story, (4) a story of heroism, (5) a biography of a great Bengali patriot, (6) a story with moral bearing, (7) a scientific story, (8) a story of geographical discoveries.

Results obtained.

Ages 7-10	Preference for fairy tale.
Ages 11-14	Preference for tale of heroism.
Ages 15-16	Preference for biography.

8. The effects of speed and of release on the rotation of the Kymograph.

R. GHOSH, Calcutta.

The kymograph varies enormously in the speed of rotation. The Stoelting variety of kymograph was tested. Graphical records of speed and release were taken and the data tabulated.

9. Study of ergograms.

R. GHOSH, Calcutta.

One hundred ergograms with the ergograph devised by Dr. Bose were obtained during the period of the Health Welfare Exhibition in 1934. The

characteristic features of ergograms in cases of different individuals have been studied. The rhythm of action in each case has been noted.

10. Errors in the learning of elementary arithmetic.

S. S. JALOTA, Lahore.

The paper reports on the nature and frequency of errors observed in 230 written and 117 oral questions set in the December ('33) examination of one section of the 5th class of the D.A.V. Middle School, Lahore. This is the juniormost class that answer their papers in copy-books. The lower classes do their sums on slates, hence their records were not available.

The various types of errors that were noticed are given. Typical errors are illustrated. It is an attempt to stimulate interest in the experimental investigations of the school problems, to point out the extent and richness of this field of research, and to emphasize a co-operative attack upon the above.

11. Child Psychology.—Play instinct develops in corporate life. Project and Drama. Means for the healthy way of sublimation.

MISS S. GHOSH, Mayurbhanj.

We have the principle of harmony or balance, the principle of nothing in 'excess'. Play instinct can be fostered through the project method. The child can give play to his play instinct through drama. Our children will realize the highest aim of life through play. The psychologist will understand a child better on the play-ground where he gives play to all his instincts and emotions. The most urgent question before the educators of to-day is whether they are to foster the most important instincts and emotions of the children or to repress them.

All the institutions of culture since man began to realize himself have been based upon the inner conviction that the individual can not only be maintained in health and sanity, but can be altered, amended, can grow in sentiments, tastes, and aspirations. The educators have always admitted an obligation as regards the single individual, they are by no means so clear when contemplating the fortunes of mankind as a whole, or of separate classes or nations within a community, until recently this aspect of educational aims was seldom faced either by educator or moralist, although Plato was an illustrious exception. Educational theory concerned itself almost exclusively with the single pupil and ignored the problems of corporate life and social contacts simply because the thoughts of men were not open, as they are in this epoch to a vista of social development. Theology bade men to look for a better world 'beyond the grave'. The historian pointed sadly to the 'decline and fall' of ancient empires, although hopeful at times that our own civilization would meet with a better fate.

12. Application of Binet, Simon, and Piaget reasoning tests to a group of 55 children, aged 7 years.

MISS S. B. GUPTA, Rangpur.

I. Division of Binet-Simon tests into (i) reasoning tests, and (ii) non-reasoning tests.

Applications of some of the reasoning tests, viz. : (a) Description of a picture ; (b) Ball and Field test ; (c) Giving differences from memory ; and (d) Giving similarities, to find how they are tackled by children of different mental ages.

II. Tests used by Piaget.

Types of relations used by the conjunctions 'Because' and 'Therefore'.

Conclusions arrived at: (a) Both causal and logical relations are understood by some children at this stage; (b) Socialization of thought takes place; (c) Some thoughts are undirected, but mostly they are directed; (d) Juxtaposition or inversion of facts has been noticed; (e) A child between 6 and 8 reasons, but may be ignorant of formal logical justification; (f) In using 'Therefore' 83.4 per cent. of children showed:—

- (i) absence of conscious realization;
- (ii) absence of general propositions;
- (iii) absence of deduction.

III. Formal thought and Relational judgments.

Binet-Simon absurdity phrases were used to find out whether children between 6 and 8 can assume hypotheses to do formal reasoning. Four tests, namely, 'Poor cyclist', 'Young girls', 'Friday', and 'Three brothers', are fully analyzed to show how the children handled them. Percentages of successful answers show that 'Friday test' was the most difficult to understand. Faulty reasoning and not ego-centricity is the cause of failure.

Conclusion arrived at: (a) Some children can assume hypotheses without questioning their legitimacy; (b) Some are able to find the contradiction in thought and succeed in stating their reasons methodically; and (c) Some arrive at the stage of verification.

Idea of Relationship: (a) A child understands membership sooner than relationship; (b) Next he understands both but cannot apply the same to any case beyond his own; (c) Lastly he surpasses this stage of ego-centrism; (d) Ideas of family, uncle and aunt are for a long time verbal and practical.

How the child reasons. Process of true reasoning includes (a) introspection; (b) comparison; and (c) self-criticism. (b) and (c) become possible after (a).

In the field of reasoning the child passes through the stages as follows: (a) State of omniscience; (b) Stage of refusal; (c) Stage of imaginary hypotheses based on chance-coincidences; (d) Stage of intellectual imaginary hypotheses based on one of the 10 relations of Spearman's; (e) Stage of possibility of more than one hypothesis; (f) Stage of comparison between possibilities; (g) Stage of verification and criticism; (h) Stage of selection and generalization.

13. On the validity of a group test of intelligence in Bengal.

P. C. MAHALANOBIS, Calcutta.

A group test of intelligence in Bengali, designed by the author, has been discussed in previous communication and in three recent studies. The value of these tests in forecasting success in school examinations is discussed in this paper.

14. The cutaneous sense.

K. C. MUKHERJI, Dacca.

In this paper the structural peculiarities of the epidermis and of the dermis are as far as possible made clear. Their relation with the different spots of the skin has also been referred to. Different opinions as to the character of the spots, their connection with the sensory nerves and also the specific conduction of stimulation to higher centres have been critically discussed.

15. The psychology of laughter.

N. MUKHERJI, Calcutta.

A study of the expression of emotion. The physiology of laughter. Its position on ontogenetic and phylogenetic developmental scale. Some of the psychological aspects. Smiles included. An interpretation attempted.

16. Present status of the problem of learning.

JAMUNA PRASAD, Patna.

A brief sketch of theories of learning. Behaviourism. Learning consists in the establishment of conditioned reflexes. This neglects situational and motivating factors. Discrete responses to discrete stimuli are an inadequate account. Overt trial and error method. No essential difference between this and the conditioned reflex theory except that it emphasizes the rôle of effective factors (satisfaction and annoyance) in conditioning the responses. Blind and accidental—no problem nor a new mode of response. Gestalt Theory. Learning is the solution of a problem by insight. It neglects the motor and over-emphasizes the situational factor. Skilled movements and the insight theory.

The search for one single formula does not promise success. Motor and intelligent factors are both involved in learning. Motor factors comprise conditioned reflexes; intelligent factors comprise (a) the ability to acquire new responses by re-organization, (b) apprehension of the problem and of the key to its solution. In motor learning among animals the effective factors condition the responses; but intelligent factors are not entirely wanting. In intelligent learning (as among chimpanzees and human beings) apprehension of the problem, trial search for, and discovery of, the key to the solution, and conditioning of motor responses through intelligent factors, are all present.

17. Group testing of memory.

H. P. MAITI and R. GHOSH, Calcutta.

Two hundred school boys acted as subjects. Memories for digits, nonsense syllables, nonsense geometrical figures, names of common objects, words of abstract ideas, short sentences of information, and short stories were tested. The teachers' estimates of intelligence and results of the school examinations were compared with the scores obtained in the memory tests. These experiments were performed in the class rooms during the school periods and before the class teachers.

18. Size-weight illusion.

G. PAL, Calcutta.

Size-weight illusion is investigated, measured, and compared under different 'attitudes'.

19. Children's whys.

G. PAL, Calcutta.

An attempt is made to analyze the 'whys' of Bengali children varying from 3 to 8 years.

20. Children's play.

G. PAL and R. GHOSH, Calcutta.

This paper records 200 forms of play-activities found among children of Calcutta, while playing in parks and similar public places. This paper records 'solitary' and 'group' plays of children, varying between the ages $2\frac{1}{2}$ years and 8 years. These children are of different sexes, of various nationalities, and have different home environments.

21. Bengali *chhara*.

G. PAL and R. GHOSH, Calcutta.

Chharas are abundantly current among Bengali children and in Bengali homes. They are learnt orally from playmates and elders. The study of 150 such *chharas* is given in this paper. These, like folk-songs, help in understanding the social mind.

22. Four dreams of an ascetic disciple who has taken the vow of celibacy.

S. L. SARKAR, Calcutta.

23. Psychology of co-education.

J. K. SARKAR, Muzaffarpur.

Two ideals of education. The dual education, and co-education. Psychology of idealization.

The methods of segregation and association. Their merits and demerits. Their psychological basis.

Conclusion. Hyphenated education at home, separated education at school, and re-education of parents.

24. Drawings of Bengali children.

G. PAL and A. DATTA, Calcutta.

The human figure was used as the subject for drawing. By a careful analysis of the separate elements in the drawings of nearly 300 children of different ages. The significant features for each age were tabulated. Further, by means of very minute and careful measurements of the relative proportions of the various parts of the drawings, and by thorough examinations of the spatial relationships of these different parts, an attempt was made to establish a series of norms or 'standards of excellence' for each age.

25. The psychology of sensation.

S. BOSE, Calcutta.

The paper embodies recent criticism against the current concept of sensation and seeks to support the theory that the entire content of consciousness is composed of a stuff that may be fittingly designated as 'affective tone' or 'feeling-value'. Experience is *social* throughout, and the whole continuum of experience is affective. Views of the two most important schools of Psychology—the Gestalt school and the Psycho-Analytical school—are in favour of the above theory. Analysis of certain elementary sensory experiences by two trained subjects points to the primacy of affection.

26. The ergogram as a diagnostic test in psychiatry.

H. P. MATTI, Calcutta.

The study presents ergographic records characteristic of different types of mental diseases and of different grades of amentia. An attempt is made to explain the peculiarities in mental terms.

27. Art and the unconscious.

RANGIN HALDAR, Patna.

Unconscious wishes are fulfilled in artistic expressions. Art is both like and unlike dreams and neuroses. Repression plays a very important part in the creation of art. The sentiment of the beautiful is nothing but the pleasure of wish-fulfilment in disguised forms under certain conditions.

28. A new approach to the study of language.

A. LATIF, Lahore.

General Discussions.

I. CEREAL RUSTS IN INDIA.

Sections of Botany and Agriculture.

DR. K. C. MEHTA opened the discussion by reviewing his investigations into the rusts of wheat, barley and oats during the last five years.

In the absence of alternative hosts on the plains the annual propagation and spread has been cleverly brought home to the continuous presence of viable uredospores in the hills, the spores living on self sown wheats, barley and oats. The infection has been traced to the winds becoming laden with spores and the spores being carried long distances by upper currents of air. In the hills barberries and *Thalictrum* have been found infected with rust but the disease appears long after the appearance of rust on wheat.

The various devices for exposing slides at high altitudes invented by Dr. Mehta and Mr. Chatterji were then explained, and the time of the spread of viable rust spores correlated with the appearance of rust in the fields. There was striking correlation. The different physiological strains of rusts met with in India are few in comparison with those met with in U.S.A., and this was explained because the fungus could not intensively hybridize in the absence of secondary or alternative hosts.

The annual loss due to rusts is enormous; control measures are breeding resistant varieties, and an effort is being made to eradicate the disease in the hills by the suspension of wheat crops and vigorous destruction of the diseased material.

DR. SHAW then took up the problem from the point of view of a plant breeder and emphasized that the only effective way to combat the disease was by breeding resistant varieties. (1) This is difficult as it is not possible to cross directly the economically good varieties of wheat with the resistant varieties. (2) The resistance to one strain of rust is not effective in preventing attack by other strains of the fungus.

He pointed out how other characteristics of the plants affected or prevented the attack of the disease. The time of stomatal opening, in two varieties otherwise very similar, determined the resistance or susceptibility. The early opening variety was susceptible because of the presence of optimum moisture which facilitated the germination of the uredospores and consequent penetration of the hyphae into the stomatal opening, while the variety in which the time of stomatal opening was late remained resistant because of the unfavourable condition for the uredospores to germinate when the stomata opened.

MR. BURR said that he saw the Indian and European barberries growing side by side at Dr. Mehta's Simla laboratory and found that Indian barberries were resistant while foreign ones were susceptible. He thought that the question whether an embargo should be placed on importation of foreign strains would have to be considered, but, in the meantime, it would be very useful if systematic botanists throughout India would bring to the notice of the Imperial Council of Agricultural Research any instances of imported barberries being grown as ornamental plants or otherwise, so that the Council might see whether susceptible forms already exist in the country.

MR. P. K. DEY said that while appreciating the great advance in the knowledge of rusts brought about by the researches of Dr. Mehta, he could not be quite convinced of the disease being due only to the wind borne infection from the hills. He asked why lower leaves were affected

in preference to top ones which received highest infection as the infection came from above? Also why was the whole field found to be simultaneously affected instead of random areas as would be presumed from the mode of infection. The possibility of the spores remaining dormant in the soil nutrients should not be completely abandoned. Protected and non-protected fields should be laid to prove definitely the mode of infection.

DR. H. CHAUDHURY said that he had noticed a peculiar case at Lyallpur. Two distant plots of Australian wheat were found to be affected with rust but the indigenous varieties of wheat growing by the side of these plots had been found to be quite healthy. Did such cases normally occur?

DR. RAMDAS asked why emphasis was placed on the upper layers of the air currents as being the carriers of the spores instead of the lower layer? The lower layers should not be neglected in such problems.

DR. NEHRU suggested that the electric cultures might be useful in checking the disease. A baby cine on a flying machine may be useful in collecting data of the spore distribution in the upper layer of the air.

DR. BAGCHI said that there should be more intensive research in differentiating physiological forms. At present very small difference was deemed sufficient for forming a new strain. This practice should be discontinued and only after detailed study and recurring major differences should the division into physiological strains be made.

DR. MEHTA replied to the various points raised in the debate and said that he was not prepared to affirm at this stage that the alternate hosts had no part in the annual cycle of black and brown rusts. Circumstantial evidence however showed that the air currents laden with uredospores from the hills were mainly responsible for the disease in plains of India.

That loss of viability of uredospores was complete in the plains has been shown by experiments at his research station. Seed borne infection was non-existent. Greater humidity of the near lower leaves favoured spore germination; hence these are attacked in preference to the top leaves.

Differential host studies are in progress.

II. THE NORTH BIHAR EARTHQUAKE, 1934.

Sections of Mathematics and Physics and Geology.

A symposium on the origin of the North Bihar Earthquake of January 15, 1934, was held at a joint meeting of the Mathematics and Physics and Geology sections, under the chairmanship of Dr. L. L. Fermor.

DR. FERMROR, in introducing the subject, said that earthquakes in India were a matter of interest to both the Geological Survey and the Meteorological Department. The Meteorological Department maintained the instruments which recorded the shocks, and the Geological Survey undertook the collection of evidence in the field after the occurrence of important earthquakes, and prepared a general report of the earthquake. It had been his duty to send a party of officers to the field to study the great earthquake of January 15, 1934, and four officers, namely: Mr. D. N. Wadia, Dr. J. A. Dunn, and Messrs. J. B. Auden and Austin M. N. Ghosh, were detailed for this work. Fortunately, Dr. Fermor had been able to arrange for Mr. Auden to visit Nepal and study the effects of the earthquake there. As a result of this field work, a preliminary paper on the earthquake by Messrs. Auden and Ghosh had been published in the Records of the Geological Survey of India in September last.

DR. S. K. BANERJI thought that the earthquake which occurred in North Bihar on January 15, 1934, had many important peculiarities and raised many important scientific questions. The shock was felt over an

area of not less than 3 million square miles—an area which is perhaps greater than that of any earthquake recorded during the last 100 years. An important feature which has been prominently brought to notice is the inequality of propagation of surface vibrations in different directions. These were felt at greater distances towards the south and the west than the north and east, the Himalayas in the north and the Assam and Burma mountains in the east acting as barriers and damping them out considerably. That these mountain folds and fault planes which bound them should obstruct the normal propagation of surface waves is what we should expect from the point of view of seismology and the fact is therefore of considerable interest to seismologists.

An earthquake of severe intensity has usually an energy of the order of 10^{21} ergs, but the present earthquake appears to have energy slightly greater than 10^{22} ergs. There are several methods by which the calculation of the energy of the earthquake can be made, but the simplest one is to use the results obtained theoretically by Nakano that for an earthquake of shallow focus 0.4 of the energy sent out from a compressional disturbance and 0.9 of that from a distortional one goes into surface waves. If then we estimate by means of seismograms the velocity of ground movements at some fixed distance, say 200 km., all round and also estimate the length of the wave train carrying most of the energy, we can immediately calculate the total energy of the earthquake. An energy of the order of 10^{22} ergs could be produced by the fracture of a quadrangular rock of dimensions not less than 150 km. \times 100 km. and thickness 10 km. This would suggest that the focus of this earthquake must have covered a wide volume and the epicentral tract a fairly wide area.

The very great preponderance of surface waves in this earthquake, as well as the type of movements in the preliminary and the secondary phases, all suggest that this earthquake had a shallow focus. With this information in our possession, the question arises whether seismology can make any definite contribution to the search for the cause of this earthquake.

It is almost certain that isostatic compensation holds in the case of such large mountains as the Himalayas. For suppose that compensation did not hold, and that the Himalayas could be supported by the strength of the crust and the substratum. Calculation shows that the stress difference required to support the mountains of height 10,000 metres above the adjacent valleys in a uniform crust would be about 10^9 dynes/Cm.² This is near the crushing strength of basalt, which could, therefore, just support the Himalayas if the stresses necessary could be distributed over an infinite depth. On the other hand, a mass 700 metres in height and of horizontal extent small in comparison with the thickness of the lithosphere (which is an unknown quality probably 30 to 50 km.), will produce a maximum stress in the lithosphere of only 3×10^8 dynes/Cm.², which could be supported easily. The Himalayas apart from being very high are of such horizontal extent that they would produce breaking stresses in the lithosphere assumed to be of finite thickness. It is therefore very likely that they are bounded by fault planes so that they can move up and down independently, that is to say, float on the lithosphere and undergo up and down movements without distributing the surface crust over the continents. But can the relationship between the mountains and the continent be so simple as this? The fault planes being planes of fractures are probably inclined to the vertical. A clear gap does not apparently exist. There are probably huge rocks connecting the mountains and the continents across the fault planes. Any upward or downward movement of the mountains will necessarily introduce considerable stress in these rocks and if the elastic limit is reached, breaking will occur. Was a process like this the cause of the present earthquake? The upward motion of the mountains can of course occur as a consequence of denudation and if they are floating more or less independently of the continents the gravity anomalies found in the Gangetic plain and elsewhere are probably not of much importance,

as undoubtedly the strength of the continental crust, by which I mean the cohesion of the materials forming the continental crust, is able to support a small departure from perfect isostasy.

The earthquake occurred on a new moon day, and on such a day we get a body tide due to the elastic yielding of the solid material of the earth, such that the height of the oceans, as measured by the rise and fall of the sea, relative to the land is reduced to about $\frac{1}{3}$ of the true equilibrium height (if the rigidity of earth be assumed to be the same as that of steel). On that day also an atmospheric disturbance was passing over Northern India, and Darwin has shown that if the difference of barometric pressure between consecutive regions of 'high' and 'low' pressures be 5 cm. of mercury, and if the centres of 'high' and 'low' be 1,500 miles apart, then as a consequence of the yielding of the ground, it will be 9 cm. higher under the barometric depression than under the elevation. These causes could therefore conceivably have served to produce a kind of trigger action.

If the earthquake was due to a single fracture, and if the waves had travelled in a homogeneous medium, then we should get single impulses in all the three phases of our seismograph record. Actually we never get them as such. The oscillations can be lengthened out in all the phases if they have travelled in a dispersive medium or have undergone reflections and refractions in a heterogeneous medium. On these ideas it has been found possible to draw important conclusions regarding the stratification in the upper layers of the earth's surface from a study of seismograms of near earthquakes. The importance of having good seismograms of near earthquakes cannot therefore be overestimated. Unfortunately almost all the Indian seismographs failed to give a complete or faultless record of the Bihar earthquake and we should look for some suitable seismograph which will function under conditions such as we had experienced during that shock. I have been working for sometime in devising an instrument of this type which I have named a hydraulic seismograph; it is still in the experimental stage and a preliminary account of it was published some time ago in *Nature* (1933). The instrument uses hydraulic magnification and damping, is very simple in design and nothing can go out of order even when the ground moves violently. It has been considerably improved since the note appeared in *Nature*. If an instrument of this kind be kept in action by scientific institutions in Northern India, valuable records could be obtained during such catastrophes in the future. Apart from the question of stratification, such instruments will enable us to obtain accurate information regarding the velocity and acceleration of ground movements near the epicentres.

The question has been raised whether it would be possible to arrange for earthquake warning. We do not know of any scientific method by which this can be done any considerable time ahead, but surely it should be possible in big industrial centres and offices or hotels or important private residences to work a series of warning bells on the incidence of an earthquake or its foreshock by means of a simple pendulum and a magnifying lever, the gap between the lever and a metal ring being so adjusted that an electric contact is made long before the oscillations exceed the safety of the buildings. The instrument should be enclosed inside a glass case to prevent interference; the question, however, is probably not of much importance considering that devastating shocks of this kind recur in any particular place only after the lapse of many years.

Dr. S. C. Roy said that in a note on 'The Focal Region of the North Bihar Earthquake of January 15, 1934', published in the last May issue of 'Current Science' (*Curr. Sci.*, 11, p. 419, (1934), it was pointed out that the phases P, P', P'', and S, S', S'' were identifiable on the records of the Indian seismic stations lying within an epicentral distance of about

1,000 kms. Since then it has been possible to obtain and study the original seismograms of some Indian stations and also photostat copies of records from the neighbouring extra-Indian stations within a distance of 6,000 kms. It may be of interest to note that the phase \bar{P} has been identified on the seismograms of such distant stations as Bombay, Medan, Batavia and Amboina. As far as the present writer is aware the phase \bar{P} has not been detected on the seismograms of any previous earthquake shocks at epicentral distances greater than 1,000 kms. If the author's reading of the seismograms of the great North Bihar Earthquake is correct, the observation of \bar{P} to a distance of at least about 6,000 kms. would be a useful addition to the existing knowledge of the time-distance curve of this seismic phase. Another interesting feature of the seismograms of the great shock is that the incidence of the primary waves with a definite big impetus (iP) was preceded by emergent small tremors (eP) of a few seconds duration. The phases eP and iP are seen clearly on all the available records. This character of the P -incidence has also been noted independently in the tabulations of the shock by such distant stations as Hongkong, Nanking and Kew. The duration of the fore-running tremors (eP) is within 6 to 8 seconds at different stations, and may be regarded as constant at all distances. This seismographic observation may be explained by supposing that the major failure which led to the great shock was preceded by a minor failure by about 6 to 8 seconds. The epicentral region of the great shock of January 15 is tentatively located near Lat. $26^{\circ} 6' N.$ and Long. $86^{\circ} 2' E.$ with origin time of eP as 8 h. 43 m. 16 s. G.M.T. The average velocities (α) of the three longitudinal waves and those (β) of the three distortional waves calculated from the seismic data of the North Bihar shocks are :—

	$\alpha \times 10^{-5}$ (C.G.S.)	$\beta \times 10^{-5}$ (C.G.S.)
Upper layer (granitic) ..	5.23 (\bar{P})	3.17 (\bar{S})
Intermediate layer (basaltic) ..	6.24 (\bar{P})	3.72 (\bar{S})
Lower layer (ultra-basic) ..	7.78 (P)	4.26 (S)

The bulk-modulus K corresponding to the above velocities are :—

	K/ρ ($\alpha^2 - \frac{2}{3}\beta^2$) $\times 10^{-10}$ C.G.S.
Upper layer ..	14.0
Intermediate layer ..	20.5
Lower layer ..	36.3

These values of bulk-modulus when compared with the laboratory determination of elastic constants of Obsidian, Granite, Diorite, Dunite, etc. at probable temperatures and pressures of the different layers may throw some light on the constitution of the outer crust of the earth in Behar. The focal depth of the North Bihar shocks is calculated to be about 13 kms. The thickness of the upper layer is estimated to be 13.7 kms. and that of the intermediate layer as 22.2 kms. The focal depth and the thickness of the upper layer suggest that the major failure leading to the disastrous earthquake of January 15, occurred near the boundary of the upper and intermediate layers of the earth's crust.

MR. D. N. WADIA said that among the suggested causes of the recent Bihar earthquake is the one based on the theory of the *underload* of the Bihar plains, due to their being covered by thick alluvial deposits which are about 18% lighter than normal rock. The region extending from Meerut to beyond Dacca has been found by means of gravity measurements to be one of great defect of matter, as if this part of India suffers from a lack of some $\frac{1}{4}$ mile of thickness of rock-deposits. On the two flanks of this belt lie the high Himalaya to the north and the highlands of the Peninsula to the south, areas of overload where the crust supports more than the normal load. These loading anomalies must, under the

theory of isostatic balance of all large segments of the earth, cause considerable stress differences in the earth's crust—stresses which may seek relief in occasional earthquakes. The load anomaly, however, in the present case appears to be too slight (in view of the fact that the Himalaya range is more or less *compensated*) to be a competent originating cause, though it may operate as a contributory cause. Most of the great earthquakes in other parts of the world have been traced, directly or indirectly, to weak underground structures, such as folds and faults in the strata, which occasionally give way under long continued strains; and it is in the structural plan or architecture of this part of India—which has been the seat of the great majority of recorded Indian earthquakes since the XIV century—that we should seek for a cause. The underground structure below the plains of Bihar is that of a sunken trough-shaped basin filled up during late geological times by river alluvia. The floor of this sagged tract is disrupted by several fracture lines, some proved and others hypothetical, but based on collateral evidence, while there is some amount of wrinkling of the strata where the Himalaya join the plains. The great Assam earthquake of 1897 and the Kangra quake of 1905 have been definitely ascribed to slipping at the fault-line known as the 'Main Boundary Fault'—a very important zone of fractures in the earth's crust which runs along the foot of the Himalaya from the Panjab to Assam. The earthquake of January last has proved to be a complex one with three distinct epicentra two of which traverse Bihar roughly W.N.W.-E.S.E., parallel with the trend of the Himalaya, while the other was at Katmandu. The principal epicentra of the Bihar earthquake, which have given some surprise and uneasiness to Indian geologists and which throw new light on the structure of India, are two well-defined lines to the north and south of the Ganges brought out during the field investigations by the officers of the Geological Survey of India.¹ The best marked of these lines is the line from Betiah to Purnea while the other extends from Patna to Monghyr. These tracts are too far south of the boundary faults to have any connection with them, and the severe shaking which they experienced must be due to other more or less parallel fault-lines in the floor of the trough between which a block of the sub-crust underneath Bihar subsided. I would, however, mention here that the relatively high destructivity of the quake at places like Monghyr, Jamalpur, Purnea and probably also Katmandu, was due not to any special focal or nodal seismic intensity but to the accidental circumstances of their sites, which have produced local exaggeration or intensification of the earth-waves. In the case of Monghyr and Jamalpur, in my opinion, a disastrous intensification of the ground vibrations resulted from the junction of two rock bodies of quite different elasticities. These cities are built partly on ancient crystalline rock of great rigidity and partly on loose alluvial deposits. The period of vibration of such a rigid rock being quite different from that of the adjacent loosely aggregated alluvium, the elastic recoil of the latter may have produced a destructive rocking of the ground, its amplitude being too great for the old masonry houses. In the case of numerous earthquakes it has been found that the junction-plane of rock-bodies of different rigidity is a line of special weakness and destruction. In the case of Purnea the greater destructiveness of the shocks may be ascribed to the weak substratum of the town, a thick bed 60 to 80 feet, of very fine soft sand, of practically no elasticity.

All great earthquakes are succeeded by a large number, sometimes several hundreds, of aftershocks and they often throw light upon the direction and extent of the fractures in the crust which originated the principal shock. A record of such shocks during the years 1934 and 1935 is likely to have much significance on the locating of the suggested lines of

¹ Auden, J. B., and Ghosh, A. M. N.: *Rec. Geol. Surv. Ind.*, LXVIII, pp. 177-239, (1934).

faulting and dislocation underneath the Betiah-Purnea and the Patna-Monghyr epicentra. A careful and continuous record of the aftershocks in areas of great earthquakes has proved of help in studying the main quake which ushered them in. The several thousand aftershocks of the Assam earthquake of 1897 delineated the courses of the thrust-planes and faults which precipitated that great quake. The shifting of the epicentra of these subsequent minor tremors from point to point and their clustering at certain points provide data for the mapping of the subsidiary and branch faults associated with the major dislocations of the ground.

The seismic zone of India possesses but few recording stations and these more often than not fail to produce a complete graph when the intensity exceeds a certain degree or when they are situated close to the focus. It would be materially helpful if say 8 or 10 recording stations are established between Peshawar and Assam. A seismograph is not necessarily a costly instrument, nor is it necessary that all instruments should be of extreme sensitiveness. Seismographs can be constructed costing from Rs. 500 to Rs. 1,000 and can be easily kept under observation at various University laboratories and periodically visited by a meteorological expert. Such recorders may in course of time collect valuable data for use in demarcating the boundaries of the seismic belt in India. The use of microseisms in locating fault lines has been lately proved by the Japanese and American seismological laboratories, and the value of obtaining some definite data through these means regarding the course and extent of the faults, concealed under the most densely populated parts of India, cannot be overestimated.

The addition of a few seismographic observing stations may prove helpful in other ways also. Geologists have no exact idea of the depth to which the alluvial strata of the plains extend. This area is a *terra incognita* to geologists, its underground relief, composition and structure being concealed under thousands of feet of alluvial debris brought down from the Himalaya and deposited by its rivers. Seismic recorders can be utilized to obtain a more definite estimate of the thickness of the alluvium and incidentally of the nature of the floor and the existence of any hidden spurs or bluffs of rock, e.g. the one near Monghyr. They can also be put to use in seismic methods of geophysical surveying and investigation by detonating charges of dynamite at suitable depths and recording the nature of the ground waves, their echoes, velocity, etc. at experimental centres.

Mr. W. D. West said that it is generally assumed that earthquakes around India are closely associated with faults in the Himalaya or in the rocks beneath the alluvium in front of the Himalaya. But if we consider the two greatest Indian earthquakes prior to the Bihar earthquake, namely the Assam earthquake of 1897, and the Kangra valley earthquake of 1905, we find that in neither case was there any actual movement along any known Himalayan fault. The intensity of the Assam earthquake varied so remarkably from place to place, and was so widespread in its effects, that R. D. Oldham was forced to conclude that it had a deep seated origin¹; while in the case of the Kangra valley earthquake, no movement took place along any of the big faults in the Himalaya that were known to exist within the epicentral tract. In the case of the Bihar earthquake, the main epicentral area as determined by the Officers of the Geological Survey of India is covered by alluvium.² And although a subsidiary epicentre was located at Katmandu, there was no evidence of any movement having occurred along the main boundary fault, or along any other visible fault.³ In the absence, therefore, of any direct evidence for connection with faults, it is desirable to look for other possible causes.

¹ *Rec. Geol. Surv. Ind.*, XLVI, p. 59, (1926).

² *Op. cit.*, LXVIII, pl. 19, (1934).

³ *Loc. cit.*, p. 218.

The geodetic work of the Survey of India throws interesting light on the underground structure of India. Determinations of the force of gravity and of the deflection of the plumb line in a large number of places in India have revealed an anomalous distribution of crustal density, even after making allowances for the effects of topography, and for the variations in the rocks found on the surface. This led Sir Sidney Burrard to postulate his 'Hidden Range' or area of excess density within the crust, which runs across India in a W.N.W. direction through Jubbulpore. It is followed to the north by a parallel underground 'trough' in which there is a deficiency of density, the lowest point of which is beneath the northern slopes of the Himalaya. It has been suggested that this deficiency can be accounted for by the presence of the light Gangetic alluvium. But there would have to be something like 50,000 feet of alluvium to account for it, and this is extremely improbable. Similarly the high density which is observed further south above the 'Hidden Range' cannot be accounted for by the surface rocks. Moreover, the fact that there is another area of even greater gravity deficiency in Mysore, where the surface rocks are moderately dense—Deccan Trap, metamorphosed sedimentary rocks, and igneous rocks—indicates that these gravity anomalies have no connection with the density of the surface rocks. Recently this problem has been studied in greater detail by Major Glennie, who suggests that the anomalies are due to the buckling of the granitic, basaltic and dunite (or eclogite) layers of the earth's crust.¹ He postulates that there has for long been a deep trough or downward warping along the line of the geosyncline or 'Tethys' sea which is known to have existed for a long time, and in which the marine deposits were laid down which eventually gave rise to the present Himalaya on being crumpled. There are, however, two alternative ways of explaining on these lines the phenomena of a continuously sinking geosyncline. We may either assume that the granite-basalt surface, or the basalt-eclogite surface, has buckled up beneath the area of high density, and buckled down beneath the area of low density, as suggested by Glennie; or we may assume that there has been an actual change from basalt to eclogite or vice-versa. It was long ago pointed out by Dr. L. L. Fennor that basalt and eclogite are rocks having the same chemical composition but different densities, eclogite being composed of minerals, such as garnet, of high density, while basalt is composed of minerals of lower density but similar composition.² Such a change might take place with great rapidity, since the change from eclogite to basalt is an exothermic one and so might spread rapidly through a large body of rock which was near the critical point. That some such sudden and deep-seated change could produce an earthquake shock of great intensity was suggested by Oldham with reference to the Assam earthquake of 1897³, and might apply to the Bihar earthquake with its somewhat irregularly distributed isoseismal lines.⁴

It is of course fully recognized that the formation of the Himalaya during Tertiary times must have left behind a legacy of unrelieved stresses, stresses which may be continuing to-day, if not in the Himalaya themselves, perhaps in the rocks in front of the Himalaya beneath the alluvium, the relief of which might provide earthquake shocks of great intensity. Whether the Bihar earthquake was due to some sudden deep-seated change of the kind suggested above, or whether it was due to a continuation of the forces which brought the Himalaya into existence,

¹ Survey of India, Professional Paper No. 27, (1932).

² *Rec. Geol. Surv. Ind.*, XLIII, p. 41, (1913).

³ *Op cit.*, XLVI, p. 53, (1926).

⁴ Major Glennie has since pointed out to me that this form of down-warping would give rise not to underloading but to overloading, since under these conditions the alluvium filling up the depression would be an extra weight.—W. D. W.

might be decided if the depth of focus of the earthquake could be determined. If it can be shown to be more than, say, 10 kms., then the former hypothesis is more likely to be correct. A lesser depth would indicate a connection with faults in the upper rocks of the crust. Dr. Roy's estimate of 13 kms., if sound, is thus of considerable interest.

This suggestion that the Bihar earthquake (and other earthquakes around India) had a deeper seated origin than is generally supposed, and that it may have had no connection with faults within the surface rocks, is not put forward in any dogmatic way, but merely in order to show that the orthodox view concerning the association of Indian earthquakes with faults in the upper rocks may not necessarily be correct. That both the earthquakes and the formation of the Himalaya are manifestations of some change taking place at depth within the earth's crust is perhaps the more correct way of putting it.

DR. C. W. NORMAND said that the examination of the Indian seismograms recorded during the Bihar earthquake had emphasized anew three needs: (a) additional seismographs of a new type that will record the ground movement during severe earthquakes at distances up to 500 miles from the epicentre; (b) the damping of the pendulum movement of the Omori instruments; and (c) more numerous seismological stations in the neighbourhood of the Himalayan seismic zone. Regarding (a), Dr. Banerji's new instrument is in the experimental stage and promises well but need not deter other physicists from developing other designs. Regarding (c), the instruments at Calcutta, Agra and Dehra Dun ought to be supplemented at least by instruments in upper Assam, Bihar, the north Punjab or Peshawar or Kashmir, and Sind or Baluchistan. Could some colleges assist by the installation of seismological stations in these areas? An added advantage of this from the geophysicist's point of view would lie in the possible divergence of the research activities of a few more physicists in colleges in India towards geophysical studies.

PROF. A. C. BANERJI said that it is now generally recognized that earthquakes are started by fractures in the earth's crust caused by immense stress-difference developed in the layers of the crust. This stress-difference is produced by the unequal cooling of different parts of the earth's crust after solidification. These parts have contracted in volume by different amounts and a state of stress has thus been set up.

The equation for the flow of heat at a point in the earth's crust can be approximately written as:—

$$\frac{\partial T}{\partial t} - \frac{K}{sp} \frac{\partial^2 T}{\partial Z^2} = \frac{P}{s\rho}$$

where Z is the depth of the point from the surface, T is the temperature at the point, K the thermal conductivity, the density and S the specific heat. For surface rocks:—

$K=0.005$ ergs; $P=2.7$ gms./cm³; $S=0.25$ cal/gms. for 1°C.

P is the expression for the rate of generation of heat per unit volume due to radio-activity or chemical change.

It is generally accepted that the surface temperature of the earth has remained constant since solidification. The loss of heat from the surface is balanced by heat generated from radio-active substances. It is found by calculation that a depth of about 20 km. of standard surface rocks containing radio-active substances would keep the surface temperature constant. As regards the distribution of radio-active substances, three theories have been suggested:—(a) we may suppose that below a depth of 20 km., the amount of radio-active substance is negligible; (b) radio-activity falls off exponentially in the form Ae^{-az} such that below a certain depth the amount is negligible and no internal heating of the earth due to radio-active substances is possible; (c) although radio-activity decreases with depth, still its amount even at great depths is sufficient to produce internal heating of the earth.

If case (a) or (b) is true there is hardly any cooling since solidification at a depth of 800 km. or more. If case (c) is true, the temperature at such a depth might have become higher. In all the three cases, the physical state of matter at a depth of 800 km. or more has hardly changed and perhaps it shows in some respects the usual properties of the liquid. We can therefore take the thickness of the crust to be not more than 800 km.

Let us consider the case (a) or (b). Surface temperature and the temperature at a depth of 800 km. have both remained practically constant since solidification; and only the intervening layers of the crust have become cooler. So there is a layer where cooling has been most rapid and contraction in volume has become a maximum. As the outer surface of the earth undergoes no further cooling and contraction it is therefore too large to fit the contracted region situated below. There is also an intermediate layer where the contraction is just enough to fit the interior. This is the 'level of no strain'. The outer loose jacket is therefore under a horizontal crushing stress; crumpling begins at the weakest point and folds are formed. This is the initial stage of mountain building. Fractures also occur and give rise to earthquakes. Due to stretching at the surface, the available reduction of the surface of the earth for mountain-building is 4×10^{16} cm² of which 2×10^{16} cm² has been used up in mountain-formation. It is an unstable state and more folds and fractures may occur. The level of no strain is at a depth of about 150 km. Fractures may occur at any depth up to 150 km.

If the case (c) is true, then the interior regions of the earth are getting hotter and therefore they are expanding; but as the temperature of the surface is constant, it is not expanding. So the surface becomes too small to fit the expanded region below it, and fractures are liable to occur near about the surface. The focal depth of earthquakes would therefore be small.

It can be mathematically found out that deformation produces much greater stress-difference in thin crusts than in thick crusts. In the case of a thin crust, the depressed regions are compressed above and stretched below and the elevated regions are stretched above and compressed below. Moreover the maximum stress-difference is liable to occur below the greatest elevation and the greatest depression. In the case of the Himalayas there is overloading in the foot-hills and considerable underloading further south in the Gangetic valley, and consequently this great anomaly causes very great stress-difference in this region. If the stress still further increases, the crust at the point may not be strong enough to sustain it, and fracture may occur to relieve the tension.

It has been suggested that some disturbing extra-terrestrial cause may start the rupture by 'trigger action', and that the conjunction of the planets may be one such cause. Let us examine the suggestion:

We have the formula

$$\frac{f}{g} = \frac{3}{2} \frac{M}{E} \left(\frac{a}{D} \right)^3$$

where f is the intensity of the disturbing force, g the earth's gravity, E the earth's mass, M the mass of the disturbing body, a the radius of the earth, D the distance of the disturbing body from the earth. Using the above formula we get the following table for the ratio $\frac{f}{g}$ in the case of the sun, the moon, and the nearer planets at the time of their nearest approach to the earth:—

$$\text{For the moon } \frac{f_m}{g} = 8.57 \times 10^{-8}$$

$$\text{sun } \frac{f_s}{g} = 3.78 \times 10^{-8}$$

$$\text{Mercury } \frac{f_1}{g} = 5.4 \times 10^{-14}$$

$$\text{Venus } \frac{f_2}{g} = 4.6 \times 10^{-12}$$

$$\text{Mars } \frac{f_3}{g} = 2.1 \times 10^{-13}$$

$$\text{Jupiter } \frac{f_4}{g} = 6.2 \times 10^{-13}$$

$$\text{Saturn } \frac{f_5}{g} = 3.2 \times 10^{-14}$$

We find that the cumulative effect of all the planets, even at the time of conjunction, is much smaller compared with the effect produced by either the sun or the moon. So if there be any 'trigger' action, it can most possibly be by the combined action of the moon and the sun when their effects are added up at the time of a new moon. In that case more earthquakes should occur at the time of the new moon than at any other time. But it is doubtful whether lunar periodicity really dominates the occurrence of earthquakes. It has also been suggested that earthquakes are more frequent by night than by day; but available data on this subject does not conclusively prove the above statement. It is also found that the lunar tide in the atmosphere which was first investigated by Chapman has very little effect on the occurrence of earthquakes.

PROF. M. N. SAHA said that in view of the great area over which the Bihar earthquake was felt, it seemed unlikely that its focus was shallow, as suggested by Dr. S. K. Banerji. Earthquakes which are known to have a shallow focus, such as the Italian earthquakes, which occur in a volcanic region, although of great intensity at the epicentre, rapidly decrease in intensity away from the epicentre. But the reverse was the case in the Bihar earthquake, and it is likely therefore to have had a deep focus.

DR. FERMOR in summing up said that the following points seemed to have emerged from this discussion :—

(1) That a couple of hours is insufficient for a symposium upon an important subject of interest to two or three sections.

(2) That we are in great need of more seismograph stations in India.

(3) That there is an urgent need for a less delicate recording instrument that will not be put out of action by a severe earthquake. It was gratifying to learn that Dr. S. K. Banerji of the Meteorological Department had taken in hand the designing of an instrument for this purpose.

(4) That geologists are not yet certain about the cause of earthquakes, and that there is still much to be understood about the North Bihar Earthquake of 1934.

III. CELLULOSE CHEMISTRY.

Section of Chemistry.

PROF. H. K. SEN emphasized the need for understanding the relation between lignin and cellulose in lignocellulose as preliminary to a correct conception of the chemical, physical, and colloidal characteristics of cellulose itself. In the course of his experiments he had found that on acetylating lignocellulose with acetic acid—acetic anhydride mixture, without the use of any catalyst, diacetyl cellulose is the maximum stage of acetylation that can be reached. When this diacetyl cellulose is separated from lignocellulose acetate by treatment with chlorine peroxide solution, and then again acetylated with the same acetylating

mixture, it yields an insoluble triacetate. This would seem to indicate that one of the hydroxyl groups in cellulose was so attached to the lignin that further acetylation without catalyst was not possible. On removal of the lignin complex, however, this hydroxyl group could be acetylated without the use of any catalyst. The insolubility of this triacetate only shows that no degradation of the cellulose molecule had taken place during the acetylation. The conjecture, therefore, is that either the lignin complex must have so occupied the space contiguous to the hydroxyl that the entry at this position of the third acetyl group was rendered difficult, or a chemical combination with the lignin with the hydroxyl group of the cellulose is extremely possible. The difficulty in the swelling of lignocellulose may be due to this very reason, as hydration may be hindered at these very regions occupied by lignin. He further dwelt upon the merits of the Micelle theory and its utility in explaining the Viscose process and the fundamental truth underlying the Lilienfeld process.

DR. J. K. CHOWDHURY said that recent researches on cellulose had revived the older conception that the cellulose molecule is made up of a very large number of glucose units which, as established by Haworth, are linked by β -glucosidic 1-4 main valency bonds—the glucose units being given a ring structure. There is however difference of opinion as to the number of glucose units that constitute a molecule of cellulose. On the basis of careful viscosity measurements, Standinger maintains that some 800-1,000 glucose units go to form a straight fibre molecule of cellulose whose length is 1,000 times its breadth or thickness. X-ray investigations of Mark and Mayer have however led them to the opinion that about 250 glucose units make up a molecule of cellulose. A large number of investigators working on different principles such as properties of the end groups in the chain, yield of tetramethyl glucose from cellulose, osmotic and diffusion measurements of cellulose derivatives, appear to support the view of Mark and Mayer. It is however doubtful if these chemical or physical properties can really be applied to the determination of such high molecular weights. There appears to be difference in the interpretation of ultracentrifugal data which are claimed by adherents of both schools to support their views. The difficulty of molecular weight determination is further increased by the fact that cellulose in nature must be more highly polymerized than cellulose in solution. The speaker has applied the Standinger method for the determination of the molecular weight of different celluloses and has found that these molecular weights differ in different cases. Thus in the case of cotton, jute and bamboo celluloses, the number of glucose units are 978, 516 and 189 respectively. On the basis of surface tension measurements of carefully prepared viscose solutions, the speaker estimates the molecular area of the above cellulose as 571 sq. Å, 263 sq. Å and 130 sq. Å respectively. These figures indicate that the order of magnitude of the cellulose molecule is much lower than that obtained by the Standinger method. These contradictory results only prove the necessity for more extensive work in this field.

DR. E. SPENCER said that it was gratifying to learn from Prof. Sen's remarks that chemists are now beginning to realize the importance of the physical as well as the chemical characteristics of cellulose fibre. Technicians and industrial chemists in the pulp and paper trade, whose work is mainly concerned with these physical characteristics, have long recognized this.

Nothing is more striking than the difference in physical quality of the cellulose obtained from different plant fibres by the same chemical treatment, or alternatively by different chemical treatment on the same fibre. Thus, bamboo by the alkaline treatment yields a cellulose very resilient or in the paper maker's terminology very 'free', whereas wood yields a pulp less 'free' and grass yields a slimy or 'wet' cellulose. On the other hand the cellulose obtained by the alkaline treatment of wood has different characteristics from sulphite wood cellulose. Some of these differences are undoubtedly due to the presence of hemicelluloses and

degradation products, but if these are removed the resulting alpha celluloses still show distinctive variations.

Prof. Sen's suggestion that the lignin and cellulose may be associated *chemically* in the plant fibre does not seem to be borne out by microscopic examination. Thus cellulose obtained by chemical treatment from wood (ligno cellulose) does not differ materially (except in length, diameter and minor details) from cotton cellulose, which has never been associated with lignin.

Dr. Sen's suggestion that pectins and perhaps lignins may represent intermediate stages in the plant synthesis of cellulose is interesting but at present there is no experimental evidence to support this view.

In the economy of plant growth it would seem that temporary structures such as straw or grass are produced in the plant laboratory by a process of reinforcement of the cellulose skeleton or framework with pectins, gums, sugars, and starches etc. For a more permanent structure such as wood, the cellulose is reinforced with lignin and hard resins. The extreme opposite is seen in the cotton seed pod where the pure cellulose is used to give lightness without rigidity.

With reference to the production of art silk pulp, the present practice in European mills is to give a more drastic treatment than Prof. Sen indicated. Usually the pulp is subjected to two digestions followed by a fairly thorough bleaching as against one digestion for ordinary paper pulp. So little is yet known concerning the optimum conditions for the production of art silk pulp that even with the most careful control, successive batches of pulp are not exactly alike. Differences undetectable by ordinary analysis may exist and only show eventually in the sensitiveness of the final silk fibre to dyes. To overcome this difficulty the pulp is stored and blended over several months.

Experiments with bamboo pulp indicate that it may prove to be as good as woodpulp for art silk production. Its possibilities in this direction are being examined by Mr. Bhargava of the Dehra Dun Institute and independently by paper mills in India.

MR. M. P. BHARGAVA said that Dr. Sen's remarks as to the desirability of employing as mild a treatment as possible for the preparation of artificial silk pulp, so as to avoid degradation of cellulose beyond a certain limit, is sound indeed. Practical considerations, however, render the achievement of this ideal rather unrealizable. For art silk production, uniformity of pulp and the presence of ash content of not more than 0.2-0.3% are the most essential desiderata. To obtain pulp which will yield the right quality of silk on a commercial scale more or less drastic processes have to be employed in the processes of isolating the cellulose, of course keeping in view the fact that the cellulose is not degraded to such an extent that its cuprammonium viscosity falls below a certain minimum limit. We are trying to prepare pulp from bamboo for art silk at the Institute and shall very much welcome investigations on academic lines, in the light of modern views on cellulose structure at different university centres. Besides investigations on the production of pulp for art silk, there is a considerable field for the investigation of a number of fundamental problems underlying paper making. This industry has a vast field ahead of it in this country, and the Institute will very much welcome co-operative investigations of the problems with those at the various university centres who are interested in the subject.

IV. VITAMINS.

Sections of Chemistry and Medical and Veterinary Research.

DR. B. C. GUHA, in opening the discussion, directed attention to the almost phenomenal advances in our knowledge of the vitamins both in their scientific and medical aspects, which have occurred during the last

few years. He entered a strong plea for the creation of a Nutrition Board for co-ordinating nutritional researches on the varied Indian food-stuffs with due regard to the climate, soil, traditions and habits in different parts of the country. Dr. Guha said that the oils obtained from the livers of a number of Indian fishes were lately found to be very much richer than cod liver oil in their vitamin A content. Some very common Indian fruits like the guava, mango and lichi were found to be considerably more potent than the well-known anti-scorbutics—the lemon and the orange. The practical bearing of these results was obvious. Speaking from the more strictly scientific standpoint, Dr. Guha referred to the preparation of renoflavine from ox-kidney extracts, and pointed out that biological experiments indicated the existence of a relatively thermostable factor in ox-kidney extracts, which was not so well adsorbed by fuller's earth in acid solution as the flavine, but which supplemented the growth-promoting power of the flavine. What was considered to be vitamin B₂ was apparently a complex, comprising the flavine, the heat-stable factor, the anti-dermatitis and, perhaps, the anticataract factor. Dr. Guha referred also to remarkable species differences exhibited in the ability of tissues *in vitro* to convert mannose into ascorbic acid.

Dr. H. E. C. WILSON said that one of the main problems for the biochemist of to-day was to find out the rôle of vitamins in the animal economy. In this respect certain aspects of vitamin A deficiency would appear to be of interest not only to the biochemist but also to the physiologist and clinician. Two of the chief features of A deficiency were degeneration and demyelination of the nervous system and metaplasia and keratinization of epithelial tissue. The decreased resistance of epithelial surfaces to disease was considered to be secondary to this metaplasia. The interesting point however which has been brought out by Mellanby is the co-existence of nerve changes in the nerve supplying the cornea in cases of keratomalacia. This raises the question as to whether the epithelial changes are secondary to the nerve ones. The keratinization might hence be due to a lack of proper trophic control. It is here that the physiologist might take up the problem of a trophic control postulated many years ago by Haidenhein. By the clinician certain types of nerve diseases such as subacute combined degeneration and herpes might be envisaged from the nutritional standpoint. The recent work on vitamins B₁, B₂, and C showed that in all probability they were concerned in cell oxidation processes. Peters and his co-workers have shown that B₁ appears to control the removal of lactic acid and the oxygen uptake by brain tissue. Vitamin B₂, the anti-pellagra factor and flavine pigment, appears to be part of an enzyme oxidation system in many tissues (Warburg).

Vitamin C or ascorbic acid appears to be relatively labile as regards oxidation. It is found in relatively high concentration in such glands as the suprarenal cortex and pituitary. In all probability it may be concerned in the elaboration of certain hormones such as cortin or one of the active principles of the pituitary. Recent work on the pigmentary changes in Addison's disease after the administration of ascorbic acid would tend to support this view. There is at present a large field for team work between clinician, physiologist and biochemist in the problems just discussed.

PROF. N. R. DHAR said that recent research had shown that vitamin C is identical with ascorbic acid, which is a marked reducing agent capable of taking up oxygen directly from air. Ascorbic acid can be oxidised reversibly and irreversibly and it is to the double function of oxidation and reduction in the reversible change that the acid probably owes its biological activity. The parallelism between the reducing power and the antiscorbutic potency of plant extracts has been investigated by several workers. Tillmans, Hirsch and Jackisch (1932) have reported that the vitamin C content and the reducing capacity are strictly parallel. Moreover, it has been observed that carotene, which is also a reducing

agent, is the precursor of vitamin A and hence it has been called provitamin A.

These researches are in agreement with the views advanced by N. R. Dhar (New Conception in Biochemistry) that vitamins act as accelerator in the oxidation of food materials. Similarly Peters and collaborators (1929-33) have shown that the brains of polyneuritic pigeons have a high lactic acid content and the brain tissue from such pigeons has a subnormal oxygen intake and that on adding a concentrate of vitamin B to the tissue the oxygen intake is enhanced. These observations seem to support that carbohydrate metabolism is helped by vitamin B.

It seems that the vitamins associated with natural food materials, or prepared artificially, function as accelerators of their proper metabolism. When the food material is lacking in vitamins, deficiency and metabolism diseases begin and this may be followed by more serious complications. Once the metabolism is upset, the animal body may undergo various troubles and may become prone to infection.

Recently many people have observed the toxic effect of an overdose of irradiated ergosterol (Vitamin D or Calciferol). This phenomenon of hypervitaminosis observed with vitamin D and other vitamins has been explained by Dhar in the following way. Vitamin D accelerates the oxidation of fats and vitamin B and C act as promoters in the oxidation of carbohydrates. In the presence of an overdose of vitamin D fats will be rapidly oxidised, causing serious trouble in the animal body; but if there is also a large increase of vitamins B and C, carbohydrates will also be burnt quickly. It has been emphasized in publications from the Allahabad University Chemical Laboratories that when carbohydrates are oxidised in the body the oxidation of fats is greatly retarded. Hence a considerable increase in the allowance of vitamins B and C is likely to nullify the effect of an overdose of vitamin D and thus hypervitaminosis will be avoided. In presence of moderate amounts of vitamin D and in normal conditions of the body, the fats are completely oxidised to carbonic acid without the formation of stronger acids, but in the absence of vitamin D, incomplete metabolism of fats takes place and organic acids are likely to be formed and hence the amounts of calcium phosphates present in the blood, serum, etc. in the colloidal condition which is suitable for adsorption become less, due to the solvent action of the organic acids on the calcium phosphates. In presence of vitamin D the metabolism of fats is complete and the calcium phosphate existing in the blood in the colloidal condition is greater and hence bone formation is facilitated by vitamin D.

Just as vitamins A and D are useful in fat metabolism, thyroid and adrenaline secretions also seem to facilitate fat oxidation in the body. The oxidation of carbohydrates is accelerated by vitamins B and C and by insulin. The observation of Haendel and Malet (1929) that hypervitaminosis is diminished by the administration of insulin and increased by adrenaline or thyroid is clear from the foregoing observations. The function of vitamins B and C and of insulin in accelerating the oxidation of carbohydrates will appear antagonistic to the functions of vitamins A and D and of thyroid and adrenaline, which help the proper oxidation of fat in the body. The vitamins, notably C, A, and probably B, are excellent reducing agents capable of taking up oxygen directly from air, and in this process of their oxidation they can induce the oxidation of the food materials with which they are associated. Hence the recent work on vitamins and their functions supports the view advocated by Dhar and collaborators Palit, Dube and others for over ten years that biological oxidations taking place in the animal body and in the plant are mainly cases of induced oxidations.

Dr. K. C. SEN said that he wished to speak of the vitamins from the standpoint of cattle nutrition in India. It is unfortunate that not much work on this subject has been done in this country, but from the few experiments which have been done in the Muktesar Institute and the facts which we have gathered there, we have no doubt that the question

of avitaminosis is going to be one of the most important problems in relation to the health, productive capacity and reproduction in animals. My observations this morning will be confined to vitamins A, B and C only. We have now some reasons to believe, due mainly to the work of the Minnesota school, that a calf does not require any supplement of vitamins B or C in its ration, and its growth is apparently independent of any external source of these factors. Vitamin A however stands on an entirely different footing. It has been shown by many American workers, specially by Hart and collaborators in California, that there may be a relative shortage of vitamin A in pastures under certain climatic and other conditions, and that cattle reared on this pasture may suffer from three serious troubles. In very young calves, avitaminosis A may give rise to severe diarrhoea resembling white scour; in growing animals, ophthalmia and blindness; and in mature animals, expulsion of the fetus either prematurely or dead at full term. All these troubles are well known in India. Thus we receive reports of severe diarrhoea in young calves leading to their death where the possibility of bacterial infection has been ruled out, and all the available evidence points to some dietetic factor being involved in the disturbance. Abortion in cattle, often non-specific in origin and having nothing to do with *B. Abortus*, is quite common in various parts of the country. Ophthalmia and blindness in calves occur widely in Sind and Baluchistan, both in cross breeds and in indigenous cattle. During the major part of the year no grazing is available in these tracts and the animals are mostly stall-fed. An example of the practical aspect of this avitaminosis problem might be mentioned here. In one of the well-established dairies in Baluchistan, blindness in calves was a common trouble a few years ago, and in 1929, as many as 35-40% of the calves born went blind either immediately or within a few months after birth. Addition of cod liver oil and later on, green pasture daily, in the ration of the cattle has practically stopped this trouble. There is a significant coincidence that eye-troubles in human beings are also very common in this part of India.

In discussing this cattle nutrition problem, I wish to make an observation of a general nature. There is a prevailing tendency in certain quarters to consider human nutrition work as quite distinct from animal nutrition work. A study of the avitaminosis question will however show that for the proper understanding of the problem, it is essential that we take a broad view of the subject and that there should be a closer co-operation between different groups of workers. Thus to give a familiar example, it is known that the vitamin potency of milk varies in different seasons of the year due to difference in the pasture available, which means that the feeding value of milk (and hence the nutrition of children) depends ultimately on the quality of the fodders. The food value of the fodders is again dependent on soil conditions, climatic changes, etc. From the practical standpoint, we must therefore consider agricultural and animal husbandry research as of immense value for the proper understanding of the human nutrition question in this country. I may quote here the statement made by General Sir Robert McCarrison before the Royal Commission on Agriculture in 1926. 'There is no more important branch of Agricultural or Nutritional Research than that which deals with Animal Husbandry, and I wish to emphasize here that the problems of Animal Husbandry are also the problems of Human Husbandry'. I will conclude by slightly amplifying this statement. The ultimate aim of animal husbandry research and nutritional research is the same; namely, adequate nutrition of the people. There is no reason, therefore, why workers in these lines should keep themselves in isolated compartments. On the other hand, there should be the closest co-operation amongst us all for our mutual benefit and advantage and for the widening of our scientific vision.

DR. B. AHMED said that it had now been sufficiently proved that (a) carotene is the precursor of vitamin A, (b) that vitamin A as isolated from animal tissues is derived from plant carotene, and (c) further that

carotene is the only source of the vitamin A activity of all plant and vegetable foods. Since vegetable foods enter very largely and sometimes exclusively into the food of animals, the study of the metabolism of carotene is a matter of some importance. We have attempted to study this problem from three different angles.

- (i) What are the factors that affect the absorption and assimilation of carotene by the animal organism.
- (ii) How do different species of animals differ in their capacity to metabolize carotene for vitamin A formation.
- (iii) How does the change, carotene to vitamin A, take place in the animal organism.

With regard to the assimilation and absorption of carotene, it has been found that the presence of fat in the diet is an important factor. When the diet includes a normal amount (about 10-15%) of fat, 90% of the carotene fed at a moderate level is absorbed and assimilated. As the fat is slowly cut down from the diet, the absorption becomes less and less, till when fat is altogether excluded from the diet almost 90% of the carotene fed by the mouth may be recovered unchanged in the faeces.

The different species of animals have been found to differ rather widely in their capacity to form vitamin A from carotene. In a controlled experiment five different species of animals were fed with equivalent amounts of carotene under identical conditions. The animals had been previously depleted of their vitamin A reserves. For each 0.001 mg. of carotene fed to the rat, and amounts proportional to their body weights in the case of other animals, the amounts of vitamin A found in their liver at the end of 8 weeks were as follows:—

Cat	..	0 Blue units	Rabbit	..	80 Blue units
Pigeon	..	6 "	Hen	..	120 "
Rat	..	3,000 Blue units			

These results have their peculiar significance from the point of view of the herbivorous animals which have to depend entirely upon carotene for their supply of vitamin A.

For the study of the animal change of carotene to vitamin A, an attempt was made to follow the course of colloidal carotene injected into the circulation. Several species of animals were employed including the rat, rabbit, cat, dog and goat. It was observed that—

- (i) After its injection into the circulation the pigment rapidly disappears from the blood;
- (ii) the presence of the pigment particles is detected in the Kupfer cells of the liver and similar other cells of the spleen and the lungs;
- (iii) there is a general localization of the injected pigment in the liver, spleen and the lungs;
- (iv) and finally after a course of injections of carotene vitamin A appears in the liver and the spleen.

As a result of these observations it has been postulated that the reticulo-endothelial system plays an important role in the metabolism of carotene and the formation of vitamin A. This view is further supported by the analogous role of the reticulo-endothelial system in the formation of bilirubin from damaged red blood cells and the formation of antibodies from foreign proteins.

V. DISCUSSION REGARDING THE FORMATION OF A SOCIETY OF SOIL SCIENCE.

Sections of Agriculture, Mathematics and Physics, Chemistry, Botany, and Geology.

On the suggestion of the Imperial Council of Agricultural Research, a joint meeting of the above sections was held at the Twenty-first Meeting of the Indian Science Congress on the 5th January, 1934, at Bombay. The meeting 'decided to establish a National Section of the International Society of Soil Science in India', and a sub-committee consisting of Mr. B. C. Burt, C.I.E., M.B.E., B.Sc., I.A.S., Dr. S. K. Mukherjee, D.Sc. (since deceased), Mr. V. A. Tamhane, Mr. D. N. Wadia, M.A., B.Sc., F.G.S., F.R.G.S., F.A.S.B., Dr. J. C. Ghosh, D.Sc., and with Prof. J. N. Mukherjee, D.Sc., F.C.S., as Convener, was 'appointed to consider the question and formulate definite proposals regarding the same'. The committee took steps to form and register an Indian Society of Soil Science with the support of persons interested. Mr. Burt was nominated as the Provisional President, and Prof. J. N. Mukherjee as the Provisional Secretary of the Society.

At a joint meeting of the same sections held at the Twenty-second meeting of the Indian Science Congress on the 3rd January, 1935, at Calcutta, the report of the committee appointed at the last session of the Congress was considered and approved. The rules of the Society provide for the inclusion of members who are not members of the International Society, as also for close association with the latter. Rao Bahadur B. Viswanath, Mr. D. N. Wadia, and Prof. S. P. Agharkar were elected as the President, Treasurer, and Secretary respectively of the Society.

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S

Sadiqbhai, Sirajuddin.

Samal, Kalikinkar.
Samant, B. V.
Sen, Dharanidhar.
Sen, Pankaj Kumar.
Sen, Tarak Nath.
Seshan, P. K.
Shah, R. V.
Shanker, Jagadish.
Shenolikar, G. S.
Sheth, S. M.
Sidhwa, J. B.
Singh, Bahadur.
Sinha, Satish Chandra
Sircar, Sudhangsu.
Sircar, Sachindra Nath.
Srivastava, B. P.
Sukhtanker, D. R.

T

Talwalkar, S. S.
Tandon, R. K.

Y

Yunis, Mohd.

OFFICIAL.

1. RULES INDIAN SCIENCE CONGRESS.

- I. *Circular issued to the Members of the General Committee, Twenty-second Indian Science Congress, Calcutta, 1935.*

Dated 15th December, 1934.

To

THE MEMBERS OF THE GENERAL COMMITTEE,
INDIAN SCIENCE CONGRESS ASSOCIATION.

Two years ago a committee composed of Mr. Van Manen, Dr. Agharkar, and Mr. West was appointed by the Executive Committee of the Indian Science Congress Association to report on the working of the present rules of the Association, and to suggest any alterations which might have been found desirable as a result of the experience gained in working them. The committee have concluded their deliberations, and have drawn up an amended set of rules which has been considered by the Executive Committee.

The Executive Committee have approved the proposals and have decided to place them before a meeting of the General Committee to be held during the next session of the Indian Science Congress, in Calcutta, in January, 1935, in accordance with rule 22.

Any amendments by members of the General Committee should reach the undersigned before the 31st December.

W. D. WEST,
General Secretary,
Indian Science Congress Association.

II. *Old Rules, in force up to the Twenty-second Indian Science Congress, Calcutta, 1935.*

1. The name of the Association shall be the Indian Science Congress, and its object shall be the advancement of Science in India by the annual holding of the Congress and the doing of all such things as are incidental or conducive to the above object, including :

- (a) the holding and management of funds and property,
- (b) the acquisition of rights and privileges necessary or convenient for the object of the Association,
- (c) the management, development, improvement, disposal, and sale of all and any parts of the property of Association.

2. There shall be an Executive Committee which shall carry on the administrative work of the Congress and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

3. The Executive Committee shall consist of the President, the Retiring President, the two General Secretaries, and the Treasurer (who shall be the Treasurer of the Asiatic Society of Bengal for the time being) of the Congress, the General Secretary of the Asiatic Society of Bengal for the time being, and five Permanent Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Executive Committee shall co-opt as members at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

4. The Executive Committee shall have full power to transact all business in case of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

5. There shall be a General Committee which shall consist of all Permanent Members of the Congress and such Sessional Members as have held office in the Congress.

Officers of the Congress for the purpose of this Rule shall be : the Members of the Executive Committee and the Presidents and Recorders of Sections.

6. The General Committee shall meet at least once during each Session of the Congress, preferably in the middle of the Session.

7. There shall be a Council which shall consist of the Members of the Executive Committee, the Past Presidents of the Congress present in India, the Sectional Presidents for the ensuing Session, and, in addition, five Permanent Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

8. The Executive Committee shall consult the Council on matters of general scientific import and policy.

9. There shall be a President who shall be nominated by the Executive Committee, and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

10. There shall be two General Secretaries who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

11. Each General Secretary shall hold office till the termination of the fifth Session of the Congress following the confirmation of his appointment, and shall be eligible for re-appointment.

12. In the event of a vacancy amongst the General Secretaries occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary for the period up to the termination of the next Session of the Congress.

13. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

14. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

15. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

16. For the purpose of scientific deliberation during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee.

17. There shall be Sectional Presidents and Sectional Recorders who shall be appointed by the Executive Committee.

18. There shall be Sectional Committees which shall consist of the following two officers:—

- (a) The President of the Section (Convener),
- (b) The Recorder of the Section,

and, in addition, of the following members:—

- (c) All Permanent Members of the Congress who have been President or Recorder of the Section concerned,
- (d) Two members elected by the General Committee at its Annual Meeting during the Session of the Congress.

A Sectional Committee may co-opt two additional Permanent Members of the Congress of whom one at least shall be resident in the locality in which the ensuing Session of the Congress is to be held.

In the absence of the President of any Section from any of its meetings, the most senior member of the Sectional Committee present shall take the Chair.

The Sectional Committees shall meet on the opening day of each Session of the Congress and as often as may be necessary during the Session of the Congress.

Each Sectional Committee shall in its meetings during the Session of each Congress:—

- (a) nominate a Sectional President and a Sectional Recorder for next year's Session of the Congress for the consideration of the Executive Committee,
- (b) determine the detailed arrangements of the Sectional meetings,
- * (c) select the papers to be read and discussed,
- (d) delete by a two-thirds' majority any abstract from final publication in the Proceedings,
- (e) determine the contents of the Sectional record in the Proceedings.

19. (a) Any paper submitted for reading at the Session of the Congress shall be forwarded to the President of the Section concerned so as to reach him not later than a date to be fixed from time to time by the Executive Committee.

(b) Any paper submitted for reading at the Session of the Congress shall be accompanied by an abstract in triplicate.

(c) Any paper submitted for reading at the Session of the Congress shall be refereed by the Sectional President or by some person or persons appointed by him. Decisions with regard to acceptance or refusal of any paper for submission to the Sectional Committee shall be final and all reports confidential.

(d) No published paper shall be accepted.

20. The Congress shall consist of four classes of members :—

(a) *Permanent Members.*

Annual subscription Rs. 10.

The subscription shall become due on the 1st of February of each year and shall only be effective as a payment for Permanent Membership subscription if paid before the 15th of July of the year.

(b) *Sessional Members.*

Subscription Rs. 10 per session.

(c) *Associate Members.*

Subscription Rs. 5 per session.

(d) *Student Members.*

Subscription Rs. 2 per session.

(A Student Member must be duly certified by the head of his institution to be a *bona fide* student.)

Permanent and Sessional Members shall have the right of contributing papers for reading at the Session of the Congress and to receive free of charge all publications relating to the Session for which they are members.

Associate and Student Members shall have the right of contributing papers for reading at the Session of the Congress provided they have been communicated by a Permanent Member.

21. Any Permanent Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150.

22. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Indian Science Congress :—

(i) Proposals for additions to and alterations in the existing Rules of the Indian Science Congress may be placed at any time before the General Committee by the Executive Committee.

(ii) (a) Proposals for additions to and alterations in the existing Rules by any Permanent Member of the Congress shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(b) One of the General Secretaries shall circulate such proposals to all Permanent Members of the Congress at least one full month before the meeting of the General Committee.

(c) Any amendments to the proposals shall be sent by any Permanent Member of the Congress to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.

(d) The proposals together with any amendments, shall be brought up before the meeting of the General Committee at its Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds' majority of the constituent Members present at the meeting.

(Adopted the 5th January, 1931.)

III. *New Rules, Indian Science Congress Association, as recommended by the Executive Committee on the 15th December, 1934.*

1. The name of the Association shall be the Indian Science Congress Association, and its object shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including :—

- (a) the holding and management of funds and property ;
- (b) the acquisition of rights and privileges necessary or convenient for the object of the Association ;
- (c) the management, development, improvement, disposal and sale of all and any parts of the property of the Association.

2. The Association shall consist of Ordinary Members and Congress Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs. 10. The subscription shall become due on the 1st February of each year, and shall only be effective as a payment for Ordinary membership subscription if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150.

6. There shall be three classes of Congress Members :—

- (a) Full Congress Members—Subscription Rs. 10 per Session.
- (b) Associate Congress Members—Subscription Rs. 5 per Session.
- (c) Student Congress Members—Subscription Rs. 2 per Session.

7. Full Congress Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive free of charge all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Congress Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members provided such papers be communicated through an Ordinary Member of the Association.

A Student Member shall before admission be duly certified by the head of his Institution to be a *bona fide* student.

8. The official year of the Association shall commence from the 1st of February.

9. There shall be Officers of the Association consisting of the Members of the Executive Committee and Presidents and Recorders of Sections.

10. Only Ordinary Members shall hold office in the Association.

11. The term of office of all Office Bearers of the Association shall commence from the beginning of the official year and shall extend until the assumption of office by their successors appointed in accordance with the provisions of these Rules.

12. There shall be an Executive Committee which shall carry on the administrative work of the Association and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

13. The Executive Committee shall consist of the President, the previous year's President, the two General Secretaries, the Treasurer (who shall be the Treasurer of the Asiatic Society of Bengal for the time being), the Manager (who shall be the General Secretary of the Asiatic Society of Bengal for the time being), and five Ordinary Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Executive Committee shall co-opt as Members at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

14. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

15. There shall be a General Committee which shall consist of all Ordinary Members of the Association.

16. The General Committee shall meet at least once during each Session of the Congress preferably in the middle of the Session.

17. There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary Members of the Association as have held office as President, General Secretary, Treasurer, or Manager of the Association, the Sectional Presidents for the ensuing Session, and in addition five Ordinary Members of the Association elected by the General Committee at its Annual Meeting during the Session of the Congress.

18. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

19. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

20. There shall be two General Secretaries who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

21. The term of office of each General Secretary shall be for a period of five years following the confirmation of his appointment and he shall be eligible for re-appointment.

22. In the event of a vacancy amongst the General Secretaries occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary for the period up to the termination of the next Session of the Congress.

23. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

24. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

25. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

26. For the purpose of scientific deliberation during the Session of the Congress there shall be such Sections corresponding to different

branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee.

27. There shall be Sectional Presidents and Sectional Recorders who shall be appointed by the Executive Committee.

28. There shall be Sectional Committees which shall consist of the following two officers :—

- (a) The President of the Section (convener);
- (b) The Recorder of the Section, and, in addition, of the following members;
- (c) All Ordinary Members of the Association who have been President or Recorder of the Section concerned;
- (d) Two Ordinary Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

A Sectional Committee may co-opt two additional Ordinary Members of the Congress of whom one at least shall be resident in the locality in which the ensuing Session of the Congress is to be held.

29. The Sectional Committees shall meet on the opening day of each Session of the Congress and as often as may be necessary during the Session of the Congress.

In the absence of the President of any Section from any of its meetings the most senior member of the Sectional Committee present shall take the Chair.

Each Sectional Committee shall in its meetings during the Session of each Congress :—

- (a) select two panels of three Scientists (each in order of preference) to be submitted to the Executive Committee for consideration of appointment as Sectional President and Sectional Recorder for the following year's Session of the Congress;
- (b) determine the detailed arrangements of the Sectional meetings;
- (c) select the papers to be read and discussed;
- (d) delete by a two-thirds' majority any abstract from final publication in the proceedings;
- (e) determine the contents of the Sectional record in the proceedings, observing the relevant provisions of Rule 30.

30. (a) Any paper submitted for reading at the Session of the Congress shall be forwarded to the President of the Section concerned so as to reach him not later than a date to be fixed from time to time by the Executive Committee.

(b) Any paper submitted for reading at the Session of the Congress shall be accompanied by an abstract in triplicate.

(c) Any paper submitted for reading at the Session of the Congress shall be refereed by the Sectional President or by some person or persons appointed by him. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(d) No paper published elsewhere shall be accepted.

(e) No abstract shall be published in the Proceedings if the complete paper has not been available for reading before the meetings of a Section.

31. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association :—

- (i) Proposals for additions to and alterations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.
- (ii) (a) Proposals for additions to and alterations in the existing Rules by any Ordinary Member of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

- (b) One of the General Secretaries shall circulate such proposals to all Ordinary Members of the Association at least one full month before the meeting of the General Committee.
- (c) Any amendments to the proposals shall be sent by any Ordinary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.
- (d) The proposals together with any amendments, shall be brought up before the meeting of the General Committee at its Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds' majority of the constituent Members present and voting at the meeting.

(Adopted the 5th January, 1931.

Revised.....)

IV. *Amendments to the proposed New Rules, Indian Science Congress Association, as placed before the General Committee, Twenty-second Indian Science Congress, Calcutta, in its Meeting on the 5th January, 1935.*

Rao Bahadur M. R. Ramaswami Sivan : 'That the consideration of the revised rules proposed by the Executive Committee be deferred until the next General Meeting in 1936 and that, in the meanwhile, the Executive Committee issue circulars to all members asking for suggestions, and that such suggestions be again circularized and, on the basis of replies received, the Executive Committee submit such revised rules as may be deemed necessary, for consideration at the General Meeting to be held during the Congress Session in 1936.'

2. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
3. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
4. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
5. Dr. S. V. Desai : Substitute 'Fellow' for 'Ordinary Member'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
6. Dr. B. K. Das : Introduce the word 'Ordinary' before the word 'Congress' in first line.
6. (a) Dr. B. K. Das : Substitute 'Sessional' for 'Congress'.
6. (b) Dr. B. K. Das : Delete the word 'Congress'.
6. (c) Dr. B. K. Das : Delete the word 'Congress'.
7. Dr. B. K. Das : Substitute 'Sessional' for 'Congress'.
Dr. B. K. Das : Delete the word 'Congress' in the second paragraph.
Dr. S. V. Desai : Substitute 'Fellow' for 'Ordinary Member'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
10. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
11. Mr. N. N. Chatterji : Substitute 'Officers' for 'Office Bearers'.
Dr. L. L. Fermor : After the word 'Association' insert the words 'except the President'.
At the end of the Rule add 'The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor'.

13. Dr. L. L. Fermor : Substitute 'President-elect for the following year' for 'previous year's President'.
 Mr. N. N. Chatterjee : Substitute 'seven' for 'five'.
 Dr. B. K. Das : Substitute 'eight' for 'five'.
 Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Member'.
 Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
 15. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
 Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
 17. Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
 Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
 Dr. B. K. Das : Substitute 'seven' for 'five'.
 20. Dr. B. K. Das : At the end of the rule add 'Of the two General Secretaries so nominated one should be elected from amongst the Calcutta scientists and one alternately from the northern and the southern parts of India'.
 21. Dr. B. K. Das : Substitute 'three' for 'five'.
 Dr. B. K. Das : Delete the words 'and he shall be eligible for reappointment'.
 23. Mr. N. N. Chatterjee : After the word 'Secretaries' insert the words 'not exceeding two in number'.
 Dr. B. K. Das : At the end of the rule add 'on the recommendation of the Local Committee'.
 24. Dr. B. K. Das : At the end of the rule add 'on the recommendation of a particular University or Government'.
 28. Mr. N. N. Chatterjee : Delete the words 'two officers'.
 28. (d) Dr. S. V. Desai : Substitute 'Fellows' for 'Ordinary Members'.
 Dr. B. K. Das : Substitute 'Three' for 'Two'.
 Dr. B. K. Das : Substitute 'Regular' for 'Ordinary'.
 29. (a) Mr. N. N. Chatterjee : After the word 'Scientists' insert the words 'from amongst Ordinary Members'.
 Dr. B. K. Das : Delete '(Each in order of preference)'.
 Dr. B. K. Das : At the end of clause (a) add the words 'The Sectional Committee shall also forward their recommendation in a tabular form giving the names of all the candidates, together with the summary of their qualifications for the consideration of the Executive Committee'.
 30. (a) Dr. S. N. Chakravarti : Substitute '1st November' for 'a date to be fixed from time to time by the Executive Committee'.
 30. (c) Dr. B. K. Das : Substitute 'Decisions with regard to rejection of any paper shall be accompanied with sufficient reasons' for the last sentence of this clause.
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These amendments were considered by the Council at its meeting on the 2nd January, 1934. It was decided to recommend that the amendments to Rule 11 proposed by Mr. N. N. Chatterji and by Dr. L. L. Fermor, the amendment to Rule 13 proposed by Dr. L. L. Fermor, and the amendment to Rule 28 proposed by Mr. N. N. Chatterji be accepted, and that the remaining amendments be rejected. In addition the Executive Committee decided to propose amendments to Rules 2 and 28 (including consequential amendments).

At the meeting of the General Committee held on the 5th January, 1935, the recommendations of the Council were accepted, except that it was decided to revert to clause (a) in the second half of the old rule 18, in place of clause (a) in the new rule 29.

V. *New Rules, Indian Science Congress Association, as adopted by the General Committee, Twenty-second Indian Science Congress, Calcutta, in its meeting on the 5th January, 1935.*

1. The name of the Association shall be the Indian Science Congress Association, and its object shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including :—

- (a) the holding and management of funds and property ;
- (b) the acquisition of rights and privileges necessary or convenient for the object of the Association ;
- (c) the management, development, improvement, disposal, and sale of all and any parts of the property of the Association.

2. The Association shall consist of Ordinary Members and Session Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs. 10. The subscription shall become due on the 1st February of each year, and shall only be effective as a payment for Ordinary membership subscription if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150.

6. There shall be three classes of Session Members :—

- (a) Full Session Members—Subscription Rs. 10 per Session.
- (b) Associate Session Members—Subscription Rs. 5 per Session.
- (c) Student Session Members—Subscription Rs. 2 per Session.

7. Full Session Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive free of charge all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Session Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members provided such papers be communicated through an Ordinary Member of the Association.

A Student Member shall before admission be duly certified by the head of his Institution to be a *bona fide* student.

8. The official year of the Association shall commence from the 1st of February.

9. There shall be Officers of the Association consisting of the Members of the Executive Committee and Presidents and Recorders of Sections.

10. Only Ordinary Members shall hold office in the Association.

11. The term of office of all Officers of the Association except the President shall commence from the beginning of the official year and shall extend until the assumption of office by their successors appointed in accordance with the provisions of these Rules. The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor.

12. There shall be an Executive Committee which shall carry on the administrative work of the Association and submit such questions

as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

13. The Executive Committee shall consist of the President, the President-elect for the following year, the two General Secretaries, the Treasurer (who shall be the Treasurer of the Asiatic Society of Bengal for the time being), the Managing Secretary (who shall be the General Secretary of the Asiatic Society of Bengal for the time being), and five Ordinary Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Executive Committee shall co-opt as Members at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

14. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations herein-after laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

15. There shall be a General Committee which shall consist of all Ordinary Members of the Association.

16. The General Committee shall meet at least once during each Session of the Congress preferably in the middle of the Session.

17. There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary Members of the Association as have held office as President, General Secretary, Treasurer, or Managing Secretary of the Association, the Sectional Presidents for the ensuing Session, and in addition five Ordinary Members of the Association elected by the General Committee at its Annual Meeting during the Session of the Congress.

18. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

19. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

20. There shall be two General Secretaries who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

21. The term of office of each General Secretary shall be for a period of five years following the confirmation of his appointment and he shall be eligible for re-appointment.

22. In the event of a vacancy amongst the General Secretaries occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary for the period up to the termination of the next Session of the Congress.

23. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

24. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

25. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

26. For the purpose of scientific deliberation during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee.

27. There shall be Sectional Presidents and Sectional Recorders who shall be appointed by the Executive Committee.

28. There shall be Sectional Committees which shall consist of the following :—

- (a) The President of the Section (convener) ;
- (b) The Recorder of the Section ;
- (c) All Ordinary Members of the Association who have been President or Recorder of the Section concerned ;
- (d) Two Ordinary Members elected by the General Committee at its Annual Meeting during the Session of the Congress.

A Sectional Committee may co-opt two additional Ordinary Members of the Congress of whom one at least shall be resident in the locality in which the ensuing Session of the Congress is to be held.

29. The Sectional Committees shall meet on the opening day of each Session of the Congress and as often as may be necessary during the Session of the Congress.

In the absence of the President of any Section from any of its meetings the most senior member of the Sectional Committee present shall take the Chair.

Each Sectional Committee shall in its meetings during the Session of each Congress :—

- (a) nominate a Sectional President and a Sectional Recorder for next year's Session of the Congress for the consideration of the Executive Committee ;
- (b) determine the detailed arrangements of the Sectional meetings ;
- (c) select the papers to be read and discussed ;
- (d) delete by a two-thirds' majority any abstract from final publication in the proceedings ;
- (e) determine the contents of the Sectional record in the proceedings, observing the relevant provisions of Rule 30.

30. (a) Any paper submitted for reading at the Session of the Congress shall be forwarded to the President of the Section concerned so as to reach him not later than a date to be fixed from time to time by the Executive Committee.

(b) Any paper submitted for reading at the Session of the Congress shall be accompanied by an abstract in triplicate.

(c) Any paper submitted for reading at the Session of the Congress shall be refereed by the Sectional President or by some person or persons appointed by him. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(d) No paper published elsewhere shall be accepted.

(e) No abstract shall be published in the Proceedings if the complete paper has not been available for reading before the meetings of a Section.

31. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association :—

(i) Proposals for additions to and alterations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.

(ii) (a) Proposals for additions to and alterations in the existing Rules by any Ordinary Member of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(b) One of the General Secretaries shall circulate such proposals to all Ordinary Members of the Association at least one full month before the meeting of the General Committee.

- (c) Any amendments to the proposals shall be sent by any Ordinary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.
- (d) The proposals together with any amendments shall be brought up before the meeting of the General Committee at its Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds' majority of the constituent Members present and voting at the meeting.

(Adopted the 5th January, 1931. .

Revised the 5th January, 1935.)

2. THE NATIONAL INSTITUTE OF SCIENCES OF INDIA.

At the Meeting of the General Committee of the Twenty-First Indian Science Congress, held at Bombay on the 3rd January, 1934, a Sub-Committee was appointed to draft a constitution for an Indian Academy of Sciences and take necessary steps to bring it into existence. The following is the Report of the Committee.

CALCUTTA, the 4th December, 1934.

To

THE MEMBERS OF THE GENERAL COMMITTEE OF THE INDIAN
SCIENCE CONGRESS ASSOCIATION.

SIR,

I have great pleasure in forwarding herewith the following report of the Committee appointed by the General Committee at the special meeting held at Bombay on 3rd January, 1934, to draft a constitution for an Indian Academy of Sciences and take necessary steps to bring it into existence.

In accordance with their terms of reference, the Committee propose that an institution called 'The National Institute of Sciences of India' be established for the purposes mentioned in resolution 2, adopted by the General Committee. The reasons for using the term 'Institute' in preference to 'Academy' will be seen from the report and Appendix I thereto.

The functions of the National Institute have been explained in the Note on the Aims and Objects of the National Institute of Sciences of India (see Appendix I). The draft constitution (copy enclosed) contains provisions for the enlistment of Fellows, their dues, the administration of the Society and other matters relevant to its working; the details in many cases have been left over to be covered by Regulations to be framed by the Council of the National Institute as necessary.

In order that the National Institute may commence work as early as possible after the scheme is ratified by you, and in pursuance of the direction given by you to 'take necessary steps to bring the Academy into existence', the Committee have submitted their proposals for approval to one hundred eminent scientists in India representing all branches of science, and invited them to become its Foundation Fellows. An additional 25 scientists are being invited to become Foundation Fellows on the vote of the first 100 Foundation Fellows, making a total of 125 Foundation Fellows. The Foundation Fellows have been chosen on the advice of sub-committees consisting of specialists in the different branches of science, who were asked to nominate representatives of their subject up to a quota determined by the Academy Committee.

[The names of the 125 gentlemen invited to become Foundation Fellows are given in Appendix II.]

A very large proportion of these gentlemen have already accepted Foundation Fellowship, and the scheme now submitted to you for endorsement has thus been already approved by the scientists who will be called upon to work it, and it is hoped that members of the General Committee will show their appreciation of the labours of the Academy Committee appointed by them and endorse the scheme embodied in the accompanying report.

The Academy Committee consider it undesirable to give additional details regarding the unfortunate controversy between Sir C. V. Raman and themselves, as they regard this as happily terminated.

Yours faithfully,

S. P. AGHARKAR,

Joint Organizing Secretary,

Academy Committee,

Indian Science Congress Association.

REPORT TO THE GENERAL COMMITTEE OF THE INDIAN SCIENCE
CONGRESS ASSOCIATION OF THE ACADEMY COMMITTEE
APPOINTED ON THE 3RD JANUARY, 1934.

A detailed history of the movement for the foundation of an Indian Academy of Sciences was given a year ago in a pamphlet prepared by Prof. S. P. Agharkar, one of the General Secretaries of the Indian Science Congress Association. Copies of this pamphlet were distributed at the last Bombay session of the Indian Science Congress to all the members of the General Committee before the special meeting held on the 3rd January, 1934, to consider the proposals for the foundation of an Indian Academy of Sciences. It appears, nevertheless, necessary to include in the present report a short summary explaining the genesis of the movement and the further evolution thereof, resulting in the appointment of a Committee (hereinafter referred to as the 'Academy Committee') to frame a constitution for the proposed Academy.

In the autumn of 1911 Prof. P. S. MacMahon of Canning College, Lucknow, and Prof. J. L. Simonsen of the Presidency College, Madras, brought forward a proposal for the foundation of an Indian Association for the Advancement of Science. Its object and scope 'were stated to be similar to those of the British Association for the Advancement of Science, namely, to give a stronger impulse and a more systematic direction to scientific enquiry, to promote the intercourse of Societies and individuals interested in science in different parts of the country, to obtain a more general attention to the objects of Pure and Applied Science, and the removal of any disadvantages of a public kind which may impede its progress'. The proposal was widely circulated among persons of culture in this country and the scholars approached were not slow to recognize the desirability of the co-ordination of scientific work and of co-operation amongst scientific workers. As a result the first session of the Indian Science Congress was held in Calcutta on the 15th to 17th January, 1914, with the late Hon'ble Justice Sir Ashutosh Mukherjee as its first President.

The proposals for the formation of an Indian Academy of Sciences have followed lines similar to those that led to the foundation of its sponsor, the Indian Science Congress Association.

Towards the end of 1930, the Government of India addressed a letter to the Provincial Governments, Scientific Departments, Learned Societies, Universities and the Indian Science Congress on the subject of the formation in India of a National Research Council and National Committees to adhere to and co-operate with the International Research Council and certain affiliated unions respectively. Replies embodying detailed proposals were sent to the Government of India by various bodies, but apparently the financial stringency which supervened soon after prevented any action being taken thereon.

In 1930, also, the scientists of the United Provinces of Agra and Oudh formed themselves into a Provincial Academy, with the idea of affiliating themselves to an All-India Academy when formed.

In May, 1933, an editorial was published in *Current Science*¹ giving an outline of the views of its editors regarding the formation of an Indian

¹ The journal *Current Science* was itself founded as a result of resolutions passed at a special meeting held during the session of the Indian Science Congress Association in Bangalore in January, 1931. This journal is regarded as representative of the interests of the whole of India, and in view of its parentage has been in receipt of an annual donation from the funds of the Indian Science Congress Association.

Academy of Sciences. In September of the same year, the Board of Editorial Co-operators of *Current Science* issued a questionnaire on the subject and invited the opinions of the scientists of India. The scientists of Calcutta who jointly considered the questionnaire in several meetings adopted certain resolutions, and in view of the accepted position of the Indian Science Congress Association as an All-India Scientific body made a formal request that all proposals regarding the proposed Academy should be included in the agenda of the General Committee of the Indian Science Congress for discussion at its Bombay session.

In his Presidential Address at the Bombay session of the Indian Science Congress, Prof. Meghnad Saha referred in detail to the proposal to form an Indian Academy of Sciences and suggested a scheme for its formation on the model of the Royal Society of London. The whole question was thereafter discussed in a special meeting of the General Committee of the Indian Science Congress Association on the 3rd of January, 1934, when the following resolutions were passed :—

Resolution 1.—The General Committee of the Indian Science Congress thank the Editorial Board of *Current Science* for the excellent spade-work in sounding scientific opinion in India on the desirability or otherwise of having an Indian Academy of Sciences and proposing to hand over to the General Committee of the Indian Science Congress the material hitherto collected.

Resolution 2.—In the opinion of the General Committee of the Indian Science Congress, the principal purposes for which an Indian Academy of Sciences is desirable are :—

- (i) To act as a co-ordinating body between scientific societies in India, institutions, and Government scientific departments and services.
- (ii) To act as a body of scientists of eminence to promote and safeguard the interests of scientists in India and also to act as a National Research Council.
- (iii) To publish a *Comptes Rendus* of papers read before the Academy and also Memoirs and Transactions.
- (iv) To promote and maintain a liaison between men of science and men of letters.
- (v) To secure and manage funds and endowments for scientific research.
- (vi) To do such other things as may be necessary for the promotion of sciences in India.

Resolution 3.—Resolved that a committee be appointed to meet at an early date in Calcutta, with the object of drafting a constitution to be laid before the next meeting of the Indian Science Congress, and to take necessary steps for bringing the Academy into existence. The date suggested for the first meeting of the Committee is the 18th January to 21st January, 1934. (Date changed to 11th and 12th February, 1934.)

Resolution 4.—The Committee shall be constituted as follows :—

- I. The outgoing and incoming Presidents of the Indian Science Congress.
- II. One representative each of the following Societies :—
 - (i) Asiatic Society of Bengal.
 - (ii) Indian Chemical Society.
 - (iii) Indian Botanical Society.
 - (iv) Mining and Geological Institute, jointly with the Geological, Mining and Metallurgical Society.
 - (v) Indian Mathematical Society
 - (vi) Calcutta Mathematical Society
 - (vii) Benares Mathematical Society

One joint
representative.

- (viii) United Provinces Academy of Sciences.
- (ix) Indian Association for the Cultivation of Science, Calcutta.

III. Director or a representative nominated by the following All-India Government Departments :—

- (i) Botanical Survey of India.
 - (ii) Geological Survey of India.
 - (iii) Zoological Survey of India.
 - (iv) Survey of India.
 - (v) Meteorological Department.
 - (vi) Imperial Institute of Agricultural Research.
 - (vii) Imperial Forest Research Institute
 - (viii) Indian Research Fund Association.
 - (ix) Imperial Institute of Veterinary Research.
- } *One joint representative.*

IV. Director or a representative of the Indian Institute of Science, Bangalore.

V. The following five members to represent the General Committee of the Indian Science Congress :—

Prof. S. N. Bose	Dacca.
Mr. D. N. Wadia	Calcutta.
Dr. S. K. Mukerji	Lucknow.
Dr. K. G. Naik	Baroda.
Dr. H. K. Sen	Calcutta.

VI. One representative of the Editorial Board, *Current Science*, Bangalore.

The Committee has power to co-opt additional members as required.

Resolution 5.—Prof. Meghnad Saha, F.R.S., and Prof. S. P. Agharkar be appointed Organizing Secretaries.

The Academy Committee formed in accordance with these resolutions consisted of the following :—

- I. Dr. J. H. Hutton President, 22nd Ind. Sc. Congress, for 1934-35.
- Prof. M. N. Saha President, 21st Ind. Sc. Congress for 1933-34.

II. Representatives of the following Societies :—

- (i) Asiatic Society of Bengal.. Dr. L. L. Fermor.
 - (ii) Indian Chemical Society .. Prof. J. N. Mukherji.
 - (iii) Indian Botanical Society Prof. P. Parija.
 - (vi) Mining and Geological Institute and the Mining, Geological and Metallurgical Society.
 - (v) Ind. Mathematical Society
 - (vi) Benares Mathematical Society.
 - (vii) Calcutta Mathematical Society.
 - (viii) U.P. Academy of Sciences Prof. A. C. Banerji.
 - (ix) Indian Association for the Cultivation of Science. Dr. K. S. Krishnan.
- } Dr. Ganesh Prasad.

III. Representatives of the All-India Government Departments :—

- (i) Botanical Survey of India .. Mr. C. C. Calder.
- (ii) Geological Survey of India .. Dr. A. M. Heron.
- (iii) Zoological Survey of India .. Dr. Bains Prashad.

- (iv) Survey of India .. Brigadier H. J. Couchman.
 - (v) Meteorological Department .. Dr. C. W. B. Normand.
 - (vi) Imperial Institute of Agricultural Research. } Mr. L. N. Seaman.
 - (vii) Imperial Forest Research Institute. }
 - (viii) Indian Research Fund Association. Lt.-Col. A. D. Stewart.
 - (ix) Imperial Institute of Veterinary Research. No representative was nominated.
- IV. Director or a representative of the Indian Institute of Science, Bangalore :—
Sir C. V. Raman.
- V. General Committee of the Indian Science Congress Association :—
Prof. S. N. Bose.
Mr. D. N. Wadia.
Dr. S. K. Mukerji (since deceased).
Dr. K. G. Naik.
Dr. H. K. Sen.
- VI. Representative of the Editorial Board of *Current Science* :—
Prof. C. R. Narayan Rao.
- VII. Organizing Secretaries :—
Prof. M. N. Saha.
Prof. S. P. Agharkar.

The following persons were co-opted members of the Academy Committee from time to time :—

- I. Representatives of the following Societies were co-opted at the meeting held on the 11th and 12th February, 1934 :—
Indian Mathematical Society : Prof. Belekar (Nagpur), 1934.
South Indian Science Association : Dr. Subba Rao, Bangalore ; resigned on 12-4-34. Prof. Venkatesachar was nominated in his place on 15-9-34.
Society of Biological Chemists, India : Dr. Gilbert Fowler, Bangalore.
Institute of Chemists, India : Dr. E. Spencer, Calcutta.
Institution of Engineers, India : Mr. A. C. Austin, Calcutta.

The following were co-opted in their personal capacities :—

- Mr. M. Afzal Husain, Lyallpur.
Dr. Muzaffaruddin Qureishi, Hyderabad, Deccan.
- II. The following were co-opted as members at the 2nd meeting of the Academy Committee held on the 14th and 15th April, 1934 :—
Sr. T. Vijayaraghavacharya, Kt., Delhi-Simla.
Prof. S. S. Bhatnagar.
Dr. T. S. Tirumurti, Vizagapatam.
Principal C. A. King, Benares.
Dr. R. Row, Bombay.
- III. Mr. B. C. Burt, New Delhi, was co-opted member at the 3rd meeting of the Academy Committee held on 28th and 29th June, 1934.

- IV. Prof. B. Sahni, Lucknow, was co-opted a member at the 6th meeting of the Academy Committee, held on 8rd November, 1934.

The Committee regret the loss of Dr. S. K. Mukerji, who died on the 5th August, 1934.

MEETINGS OF THE ACADEMY COMMITTEE were held as follows :—

- 1st Meeting at Calcutta on the 11th and 12th February, 1934.
 2nd " " " " " 14th and 15th April, 1934.
 Emergency Meeting of the Calcutta Members on the 8th May, 1934.
 3rd Meeting at Simla on the 28th and 29th June, 1934.
 4th " at Calcutta on 11th August, 1934.
 5th " " " 15th and 16th September, 1934.
 6th " " " 3rd and 4th November, 1934.
 7th " " " 24th November, 1934.

At the first meeting of the Committee the question of procedure was first considered.

In this connection it was pointed out that Resolution 2 of the General Committee of the Indian Science Congress described in general the purposes for which the Academy was to be founded and in a way indicated the type of constitution to be devised.

It was also pointed out that according to the analysis of the replies received to the questionnaire on the subject of an Academy of Science for India, which had been sent to the Members of the Board of Editorial Co-operators of *Current Science*, the majority of the scientists who expressed their views on the subject, 'approved of the idea of seeking State aid to start an entirely new organization which would be run more or less along the lines of the Royal Society of London, the details of the constitution as also the process of initiation of the Academy to be decided by a Committee to be appointed for the purpose'.

In view of the above, it was resolved that the proposed Academy should have only one class of Members to be called 'Fellows', and that their number should be restricted.

It was further resolved first to fix the number of Foundation Fellows for the proposed Academy and their distribution among the various science groups and then to consider the constitution. It was thought further that in any case the constitution would have to be approved by the proposed Foundation Fellows before it could be put forward before the General Committee of the Indian Science Congress Association for endorsement.

It was decided to fix the number of Foundation Fellows at one hundred,*distributed among the various sciences, as follows :—

1.	<i>Mathematics and Astronomy</i>	9
2.	<i>Physics and Meteorology</i>	15
3.	<i>Chemistry including Metallurgy</i>	16
4.	<i>Medical and Veterinary Research including Experimental Psychology</i>	16
5.	<i>Zoology and Anthropology</i>	8
6.	<i>Botany</i>	8
7.	<i>Agriculture and Forest Research</i>	8
8.	<i>Geology and Geodesy</i>	8
9.	<i>Engineering</i>	6
10.	<i>Unattached</i>	6
TOTAL				100

It was further resolved that though the initial membership of the Academy should be one hundred, 25 persons be elected annually to be Fellows in the first two years, and ten persons annually thereafter.

The procedure for the nomination of the Foundation Fellows for the various science groups was then considered and it was resolved that Sub-Committees for the different subjects be appointed consisting of the members mentioned below and that the Sub-Committees be requested to nominate the required number of Fellows up to the quota agreed upon.

It was resolved to give the following instructions to the Members of the Sub-Committees :—

‘Persons nominated as Members of the Sub-Committee must include themselves in the list, must include all past Presidents of the Indian Science Congress belonging to that Section, and then choose from the past Sectional Presidents of the Indian Science Congress and any other eminent scientists who have not been Sectional Presidents.’

The list of Members of the Sub-Committees is given below :—

<i>Physics and Meteorology</i>	..	Sir C. V. Raman, Prof. M. N. Saha, and Dr. C. W. B. Normand.
<i>Chemistry</i>	..	Sir P. C. Ray, Sir M. O. Forster, and Prof. J. C. Ghosh.
<i>Geology</i>	..	Dr. L. L. Fermor, Mr. D. N. Wadia, and Mr. E. S. Pinfold.
<i>Botany</i>	..	Prof. S. R. Kashyap, Prof. B. Sahni, Prof. S. P. Agharkar, Prof. P. K. Parija, and Prof. M. O. P. Iyengar.
<i>Zoology and Anthropology</i>	..	Dr. B. Prashad, Dr. J. H. Hutton, Dr. G. Matthai, and Dr. B. S. Guha.
<i>Engineering</i>	..	Sir M. Visweshwaraya, Mr. W. C. Ash, and Dr. D. Penman.
<i>Agriculture and Forest Research.</i>		Mr. B. C. Burt, Mr. H. G. Champion, and R. B. T. S. Venkataraman.
<i>Medical and Veterinary Research and Psychology.</i>		Lt.-Col. J. B. Taylor, Lt.-Col. R. N. Chopra, Sir U. N. Brahmachari, and Mr. F. Ware.
<i>Mathematics and Astronomy</i>		Prof. Ganesh Prasad, Brigadier H. J. Couchman, Prof. N. R. Sen.

[At the 6th Meeting of the Academy Committee the Sub-Committees for Zoology and Anthropology and Engineering were reconstituted as follows :—

<i>Zoology and Anthropology</i>	..	Dr. B. Prashad, Dr. J. H. Hutton, Dr. G. Matthai, and R. B. L. K. Anantha Krishna Iyer.
<i>Engineering</i>	..	Dr. A. Jardine, Principal C. A. King, and Principal F. N. Mowdawalla.]

It was resolved to defer the consideration of the location of the Headquarters of the Academy to a later stage.

A part of the draft rules were considered and it was resolved to postpone consideration of the rest to the second meeting of the Committee to be held on the 14th and 15th April, 1934.

Before this second meeting of the Academy Committee, however, an unfortunate complication arose in the work of the Committee as a result of the Presidential Address of Sir C. V. Raman to a Conference of South Indian scientists at Bangalore on the 1st of April. In this address Sir C. V. Raman criticised adversely the work of the Academy Committee as revealed by the draft minutes of the first meeting, a copy of which had been sent to him as one of the members of the Committee. These minutes thus formed the basis of discussion in the Conference of South Indian scientists, which passed a number of resolutions thereon leading to a press controversy against the work of the Academy Committee. Subsequently Sir C. V. Raman and Dr. Subba Rao, who had

been nominated as representatives on the Academy Committee of the Indian Institute of Science, Bangalore, and South Indian Science Association respectively, sent in their resignations of the membership of the Committee.

The second meeting of the Academy Committee was almost entirely devoted to a consideration of the situation thus created, and it was resolved to communicate to Sir C. V. Raman the Committee's observations on the resolutions of the Bangalore Conference, and to request him and Dr. Subba Rao to withdraw their resignations. It was also decided to issue a press communiqué to clarify the misunderstanding and give the scientific public an idea of the work of the Academy Committee. The Committee's observations were communicated to Sir C. V. Raman in a letter dated 16th of April, 1934, to which no reply has been received.

The registration of a society called 'The Indian Academy of Sciences' at Bangalore was announced in the press on the 30th of April, and a large number of scientists all over the country simultaneously received circular letters inviting them to become Fellows of this Academy, which was stated to have been founded on 'federal lines'.

In view of the above situation an emergency meeting of the Calcutta members of the Academy Committee was held on the 8th of May, 1934, and a Sub-Committee consisting of Dr. B. Prasad, Dr. J. N. Mukherji, Dr. M. S. Krishnan, and Prof. S. P. Agharkar, was appointed to draw up a statement explaining the work of the Committee and clarifying the situation in reference to the resolutions of the Bangalore Conference. Copies of this statement were sent to scientists all over India, so that it is unnecessary to include the statement in this report.

In a letter dated 16th June, 1934, to Dr. L. L. Fermor, Sir C. V. Raman proposed a scheme for the federation of the existing Academies of Sciences in India, viz. the Asiatic Society of Bengal, the U.P. Academy of Sciences, Allahabad, and the Indian Academy of Sciences, Bangalore, as an alternative to the Academy proposed to be created by the Indian Science Congress Association. This scheme was very carefully considered by the Academy Committee in its third meeting on 28th and 29th June, but the conclusion arrived at was that as the Academy Committee had received a definite mandate from a body representative of all Sciences in India, it was too late for the Committee to abandon the work which it had undertaken. It was decided, however, to remodel the scheme of the Committee for the proposed Academy on the basis of a federal and co-ordinating Academy, and the Committee's views were duly communicated to Sir C. V. Raman by Dr. Fermor in his reply. It was also decided to change the name of the proposed Academy to 'The National Academy of Sciences of India'. The functions of the proposed institution were explained in 'A Note on the Aims and Objects of a National Academy of Sciences of India', prepared by the Chairman and the Organizing Secretaries of the Academy Committee in accordance with the discussions of the Committee on June 28th and 29th, 1934.

At the fourth meeting of the Academy Committee held on the 11th August, Sir C. V. Raman's reply to Dr. Fermor's letter was recorded, and various indirect proposals for a 'compromise' with Bangalore were considered. After careful consideration the Committee came to the conclusion that none of these schemes provided a satisfactory basis for agreement, as they involved the recognition of the Bangalore Academy as the central institution for India with its headquarters at Bangalore at least for the first 3 years. What the Committee desired was not a 'compromise' but the co-operation of all scientists in their individual capacity as also of all scientific organizations.

The fifth meeting of the Academy Committee was held on the 15th and 16th September in Calcutta. It was attended by Sir C. V. Raman, Prof. B. Venkatesachar, and Prof. C. R. Narayan Rao, who came to Calcutta to discuss the possibility of agreement between the Academy Committee and the Indian Academy of Sciences, Bangalore. At this meeting all

points of view were fully discussed and four resolutions were adopted unanimously :—

(1) That the name of the proposed National Academy should be changed to 'The National Institute of Sciences of India'.

(2) Publications of the National Institute should include :—

- (i) A summary of proceedings or papers read before all co-operating Academies of Science in India ;
- (ii) Such memoirs as may be considered necessary ; and
- (iii) Annual summary of progress of science in India.

(3) (a) The Indian Academy of Sciences, Bangalore, would not promote the formation of branches of the Academy, but could form local centres of its own members. This would apply *mutatis mutandis* to all other co-operating Academies.

(b) The proposed National Institute would not form branches in other parts of India, but would be prepared to co-operate not only with the three existing Academies, but also with such other Academies of sufficient status as may be formed in other parts of India.

(4) The agreement was to be subject to confirmation by the Foundation Fellows of the proposed National Institute to whom invitations had already been issued.

In addition it had been agreed that the functions of the National Institute were also to include :—

- (1) The organization of symposia and general discussions.
- (2) The distribution of annual grants for special purposes not provided for in departmental programmes.

Sir C. V. Raman also withdrew his resignation and rejoined the Academy Committee.

At the sixth meeting of the Academy Committee held on the 3rd and 4th of November at Calcutta, the views of the Foundation Fellows on the revised scheme involving the change of the name of the institution, were considered. The replies of the Foundation Fellows who had expressed their views in response to the invitation of the Academy Committee, showed that 21 approved of the change, while 20 were against it. Further the consensus of opinion amongst the members of the Academy Committee present was that the spirit of the September agreement had not been observed by Sir C. V. Raman ; it was, therefore, decided to clear up issues by officially addressing the Secretary of the Indian Academy of Sciences, Bangalore. It was requested that a reply to this letter should be sent in time for consideration at the next meeting of the Academy Committee on the 24th November and that certain changes that were rendered necessary by the spirit of the agreement of the 16th September, should be made in the Memorandum of Association and Constitution of the Indian Academy of Sciences, Bangalore.

The seventh meeting of the Academy Committee was held on the 24th of November. At this meeting Sir C. V. Raman, Prof. B. Venkatesachar, and Prof. C. R. Narayan Rao were present both as members of the Academy Committee and as representing the views of the Indian Academy of Sciences, Bangalore. After a long discussion the representatives of the Bangalore Academy agreed to propose for acceptance by their Council a number of changes in their original Memorandum of Association (see Appendix III), and they also reiterated their pledge of observing the terms of the September agreement both in letter and in spirit.

The differences between the proposed National Institute of Sciences of India and the Indian Academy of Sciences, Bangalore, having thus been satisfactorily composed on the basis of co-operation between the various bodies, the members of the Academy Committee present at this meeting (17 in number) found themselves able unanimously to agree to adhere to the name of 'National Institute of Sciences of India' and to

recommend this both to the Foundation Fellows and to the General Committee of the Indian Science Congress for their final acceptance.

The members of the General Committee of the Indian Science Congress will at this point ask what is the final position now that agreement has been obtained. The aims and objects of the proposed National Academy of Sciences of India were described in a note prepared after the Academy Committee meeting of the 28th and 29th June. As a result of the September agreement, this note was remodelled to suit the changed situation, and a copy of the remodelled note is attached to this report as Appendix I. The only important change is the substitution of the word 'Institute' for 'Academy', the other changes being purely verbal, and on the whole the Academy Committee consider that the term 'Institute' is more suitable than 'Academy' in view of the co-ordinating position it expects to occupy *vis-a-vis* the three existing bodies of Academy rank, namely the Asiatic Society of Bengal, the U.P. Academy of Sciences, and the Indian Academy of Sciences of Bangalore.

At the meeting of the 24th November it was resolved also to authorize the Organizing Secretaries to print and circulate to the Foundation Fellows the draft rules that had been framed. A copy of these draft rules is appended to this statement, and it is proposed to treat them as provisional rules for the first year of the National Institute's existence and to pass them finally at the first Annual General Meeting of the Institute. The rules do not prescribe any place as the headquarters of the National Institute, and on this point it is necessary to mention that at Sir C. V. Raman's suggestion the headquarters of the National Institute have been provisionally fixed at Calcutta. In this connection it is also necessary to add that the Asiatic Society of Bengal is prepared to offer accommodation for the offices of the Institute, if so requested. The Committee agreed that the present situation clearly indicates that a commencement should be made in Calcutta and that the first Council should, therefore, be formed on this basis. Nevertheless, since according to the Note on the Aims and Objects of the Institute circulated to the Foundation Fellows the vote of the Fellows is to be taken on the location of the headquarters of the Institute, it is proposed, during the first year, to invite the opinion of the Foundation Fellows on this point.

In the draft rules provision is made for a Council of 25, so as to allot enough places to headquarters to ensure a working quorum being always obtainable, as well as to allot one place each to as many of the centres of scientific research as possible. It has also been decided to provide for an additional Vice-President and an additional Member of Council to be appointed by each of the Academies co-operating with the National Institute. Further, in view of the importance of the Indian Science Congress Association and its historical relationship to the new National Institute of Sciences, provision has also been made for an additional Vice-President and an additional Member of Council to represent the Indian Science Congress Association. In view of the above, the following provisional Council of the National Institute has been selected for recommendation to the Foundation Fellows for their approval:—

President:—

Dr. L. L. Fermor, O.B.E., D.Sc. (Lond.), A.R.S.M., M.Inst.M.M., F.G.S., F.R.S., F.A.S.B., Director, Geological Survey of India, 27, Chowringhee, Calcutta.

Vice-Presidents:—

Brigadier H. J. Couchman, D.S.O., M.C., Surveyor-General of India, Calcutta.

Rai Bahadur Prof. S. R. Kashyap, B.A., M.Sc., D.Sc., I.E.S., F.A.S.B., Professor of Botany, Government College, Lahore (since deceased).

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Foreign Secretary :—

Prof. M. N. Saha, D.Sc., F.R.S., F.A.S.B., Professor of Physics, Allahabad University, Allahabad.

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Prof. S. P. Agharkar, M.A. (Bom.), Ph.D. (Berol.), F.L.S. (London), Ghose Professor of Botany, Calcutta University, 35, Ballygunge Circular Road, Calcutta.

Dr. A. M. Heron, D.Sc., F.G.S., F.R.G.S., F.R.S.E., Superintendent, Geological Survey of India, 27, Chowringhee, Calcutta.

Members of Council :—

Mr. M. Afzal Hussain, M.A., M.Sc., I.A.S., Principal, Punjab Agricultural College, Lyallpur, Punjab.

Dr. Baini Prashad, D.Sc., F.R.S.E., F.L.S., F.Z.S., F.A.S.B., Director, Zoological Survey of India, Indian Museum, Calcutta.

Mr. T. P. Bhaskara Shastri, M.A., F.R.A.S., Director, Nizamiah Observatory, Begumpet, Hyderabad, Deccan.

Prof. S. S. Bhatnagar, D.Sc., University Professor of Chemistry, Director, University Chemical Laboratories, Lahore.

Mr. B. C. Burt, C.I.E., M.B.E., B.Sc., I.A.S., Agricultural Expert, Imperial Council of Agricultural Research, New Delhi (and Simla).

Prof. Ganesh Prasad, M.A., D.Sc., Hardinge Professor of Higher Mathematics, Calcutta University, 2, Samavaya Mansions, Corporation Street, Calcutta.

Prof. J. C. Ghosh, D.Sc., Head of the Department of Chemistry, University of Dacca, Ramna, Dacca.

Dr. F. H. Gravely, D.Sc., F.A.S.B., Superintendent, Government Museum, Museum House, Egmore, Madras.

Lt.-Col. R. Knowles, B.A., M.R.C.S., L.R.C.P., F.A.S.B., I.M.S., Professor of Protozoology, School of Tropical Medicine, Calcutta.

Prof. K. S. Krishnan, D.Sc., Mahendralal Sircar Professor of Physics, Indian Association for the Cultivation of Science, 210, Bow Bazar Street, Calcutta.

Prof. S. K. Mitra, D.Sc. (Cal. and Paris), Khaira Professor of Physics, Calcutta University, University College of Science, 92, Upper Circular Road, Calcutta.

Prof. J. N. Mukherji, D.Sc. (London), F.C.S., Khaira Professor of Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

Dr. C. W. B. Normand, M.A., D.Sc., Director-General of Observatories, Meteorological Office, Poona 5.

Sir C. V. Raman, Kt., M.A., D.Sc., Ph.D., LL.D., F.R.S., F.A.S.B., N.L., Director, Indian Institute of Science, Bangalore.

Prof. B. Sahni, M.A., Sc.D., D.Sc., F.G.S., F.A.S.B., Professor of Botany, Lucknow University, Lucknow.

Lt.-Col. S. S. Sokhey, M.A., M.D., D.Sc., D.T.M. & H., I.M.S., Director, Haffkine Institute, Parel, Bombay.

Lt.-Col. J. B. Taylor, D.S.O., M.D., D.P.H., I.M.S., Director, Central Research Institute, Kasauli (Simla Hills).

Mr. C. G. Trevor, C.I.E., President, Imperial Forest Research Institute, Dehra Dun.

Mr. F. Ware, F.R.C.V.S., I.V.S., Director, Imperial Institute of Veterinary Research, Muktesar.

This list does not, of course, contain the names of the additional Vice-Presidents and Members of Council as these have yet to be chosen by the nominating bodies.

In view of the concord that has now been established, the Academy Committee has decided to exclude from this report to the General Committee both the details of their deliberations and also of the unfortunate controversy with the Indian Academy of Sciences, Bangalore. The Committee has carried on its labours under very difficult and at times almost impossible circumstances and it hopes that the members of the General Committee of the Indian Science Congress will, after careful consideration of the report now presented, be in a position to endorse the work of its Committee, and accept its proposals for the foundation of the National Institute of Sciences of India.

CALCUTTA,
3rd December, 1934.

S. P. AGHARKAR,
M. N. SAHA,
Joint Organizing Secretaries.

APPENDIX I.

A NOTE ON THE AIMS AND OBJECTS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA.

A note on the Aims and Objects of the National Academy of Sciences of India, approved by the Academy Committee of the Indian Science Congress Association, was issued with the letter of invitation dated the 18th of August, 1934, to those gentlemen who were invited to become Foundation Fellows of the proposed National Academy of Sciences of India.

At the meeting of the Academy Committee held at Calcutta, on the 15th and 16th of September, 1934, in the rooms of the Asiatic Society of Bengal, three representatives of the Indian Academy of Sciences founded at Bangalore, namely the President and the two Secretaries, were present, and as a result of discussion then undertaken, the object of which was to provide for co-operation between the proposed National Academy and the Indian Academy of Sciences of Bangalore, as well as with the two other Academies, the Asiatic Society of Bengal and the U.P. Academy of Sciences, certain changes were decided upon. For this reason it has become necessary to reconstruct the note on our aims and objects referred to above.

In the first place it was generally accepted that a more suitable title for the body to be founded by the Indian Science Congress Association would be 'The National Institute of Sciences of India' rather than 'The National Academy' on account of the fact that the activities that the National body is to undertake are somewhat different from those of an Academy as such.

The Committee consider that an Academy must be regarded as a society that deals with a variety of branches of knowledge rather than confining itself to a single branch of studies, or to closely allied branches of studies, such as is proper to specialist societies, *e.g.* The Chemical Society of India or the Mining and Geological Institute of India. They consider also that an Academy is otherwise similar to specialist societies, and exists primarily for the holding of regular periodical meetings for the purposes of reading and discussion of papers, of course, with a view to subsequent publication.

The broadest type of Academy is one that deals with all branches of knowledge. This function is already performed by the Asiatic Society of Bengal, which is, in fact, the oldest learned Society in India, and was founded before any of the specialist societies. This society comprises in its activities both Science and Letters. Until four years ago there was only this one Society of Academy rank in India, but since that date two other Academies have been formed, namely the U.P. Academy of Sciences founded in 1930, and the Indian Academy of Sciences of Bangalore founded in 1934. These two latter societies being Academies of Science only are of more restricted scope than the Asiatic Society of Bengal, whose activities comprise both Science and Letters. This completes the list of Academies at present in India. Each of these Academies has a membership that is not restricted to the province or region within which the headquarters of the Academy is situated, and to this extent each one of these Academies may regard itself as having all-India activities.

Each Academy, however, necessarily has its headquarters in a definite town or province, and to this extent it provides greater benefits to members resident at or close to the headquarters than the members of more distant residence. This fact is recognized in practice by the Asiatic Society of

Bengal and the U.P. Academy of Sciences, which charge higher fees to resident than to non resident members. Because, therefore, of the facts of geography, each of these three Academies must be regarded as having local activities in addition to all-India activities; and the proportion between the local and all-India activities of each Academy must necessarily vary according to its history and activities. The Committee consider, therefore, that the facts of geography necessitate the existence of more than one body of Academy rank in India, and that for practical purposes even these three Academies are not sufficient to meet adequately the scientific needs of the whole of India. Scanning the list of gentlemen who are being invited to become Foundation Fellows of the National Academy, gentlemen whose names have been selected after careful consideration, with due regard to the merits of each person and without reference to regional or provincial problems, it is seen that these Fellows can be classed into 5 groups, and that about 35% of them may be regarded as resident in the tract of which Calcutta is the natural centre; about 25% of them in Southern India, of which Bangalore may be accepted as the natural centre; about 13% within convenient reach of the United Provinces; and, in addition, about 13% to whom Bombay or Poona would be the most convenient centre; and about 13% for whom Lahore would be the most convenient centre.

The full development of Science in India on an Academy basis appears, therefore, logically to require the foundation of two new Academies with centres, say, at Bombay (or Poona) and at Lahore. In devising a scheme for a National Institute of Sciences of India co-operating with the Academies, we are prepared, therefore, for the possibility that scientists whose natural centre of activity is Bombay (or Poona) on the one hand and Lahore on the other may think it advantageous to the development of Science in their regions to establish Academies of Science.

With reference to the existing Academies, a scheme of co-operation with the National Institute of Sciences of India has been devised. This scheme provides for the representation of the existing Academies upon the Council of the National Institute in the form of an additional Vice-President and an additional Member of Council for each Academy elected by the respective Academies from amongst the Fellows of the National Institute who are also members of the respective Academies. Should the scientists interested decide that it is desirable to found Academies of Science at Bombay or Poona and at Lahore, the National Institute will be prepared to offer them also an additional place as Vice-President and an additional place as a Member of Council, provided the Academies so founded contain a minimum number of Fellows of the National Institute.

It appears to be unnecessary to found a new Academy in Calcutta, as the Committee hope that the Asiatic Society of Bengal will be prepared to develop its activities on the Science side in order that this may be avoided. The Academy Committee make this recommendation with the hesitation and deference which is necessary to a body of such a distinguished past and long career as the Asiatic Society of Bengal.

The fact that an existing Academy undertakes to co-operate with the National Institute for particular purposes will not, in any way, detract from its independence or dignity, or prevent it from continuing to have all-India interests and activities.

Assuming that the three existing Academies will be prepared to adopt the scheme of co-operation with the National Institute outlined at a meeting of the Academy Committee held on September the 15th and 16th, and also that the two suggested additional Academies, if formed, will be prepared to cater for the general interests of all scientists in their natural sphere of influence, irrespective of juniority or seniority of members, it is unnecessary for the National Institute to enter into competition with them in this respect. For the National Institute we need only a body of

Fellows elected for their eminence, whose general duties will be to co-ordinate scientific effort throughout India.

It is proposed that at present we should start with 125 Foundation Fellows, of whom 100 have been selected by the procedure devised by the Academy Committee, and that these 100 Fellows shall select the remaining 25 Fellows in accordance with the Academy Committee's quotas. Ten new Fellows will be elected in the first year after the formal constitution of the Institute, and 10 annually thereafter. The latter figure is not, of course, an inflexible figure, but one to which it is proposed to adhere for the first few years.

Although it is not proposed to make it compulsory that every Fellow of the National Institute shall also be a member of one of the three or more Academies, yet it is hoped that the majority will so belong. It is recognized, however, that there are likely to be a few Fellows left over who, for geographical reasons, cannot benefit by membership of any Academy, and for this reason it is not proposed to make such membership compulsory.

The proposal is that the dues required from Fellows should be an admission fee of Rs. 32 and an annual subscription of Rs. 36. If the existing Academies enter into the scheme of co-operation, it is proposed that the National Institute shall contribute to the Academies Rs. 12 per member per National Institute Fellow towards his membership subscription of his Academy. In the case where a Fellow is a member of more than one Academy, he will be asked to name the Academy to which he elects to have Rs. 12 of his subscription transferred. In the case of Fellows who do not belong to any Academy, the National Institute will retain the whole subscription.

Concerning publications, it is proposed that the National Institute should publish a summary of papers read before the co-operating Academies in order to enable the National Institute to issue a consolidated *Comptes rendus* of papers read before all the Academies. In addition, the National Institute propose to publish an Annual Review of the Progress of Science in India, dealt with subject by subject. Thirdly, in cases where Academies are unable, for financial reasons, to publish large and expensive Memoirs, the National Institute propose to undertake this duty when so requested. On the other hand, it is expected that the Academies will publish their own Journals with papers read at their meetings. Should any Academy, however, find itself financially unable to publish papers read before it, the National Institute will be prepared to consider their publication.

Concerning meetings of the National Institute, it is not the intention to hold regular periodical meetings for the reading of papers, as this work is regarded as the prime function of the Academies. To commence with, therefore, and for business purposes, two meetings only per year will be necessary, one at the headquarters of the Institute, say, during the monsoon season, and one perhaps at the city selected for the meeting of the Indian Science Congress of that year. Additional meetings for business and other purposes will be held when necessary. Proceedings of meetings of the Institute will also be published.

The above indicates the extent to which the Institute will act as a body for publication. In addition, one of the major activities at which the National Institute should aim is the organization of a National Research Council and of National Research Committees for India when so desired by Government. Such organizations would contain not only representatives of the National Institute, but of the Academies and of the relative specialist societies, as well as of the various scientific services, and in this way co-operation will be ensured between the Institute, the Academies, the specialist scientific societies, and the Government as represented by scientific services.

The scheme of co-operation also includes that the National Institute should arrange for discussions and symposia on special topics of general

natural and scientific interest as is done by the Royal Society and the Faraday Society.

Another object which we have to keep before us in accordance with the resolutions of the Indian Science Congress is the preservation by the Institute of a liaison between Science and Letters.

We consider that for the present this portion of our aims should be kept in abeyance and that the Institute should first be brought into being and activity as a purely Science Institute; when this has been effected, we shall be in a position to consider what form of liaison, if any, with Letters is desirable and practicable.

With reference to finance, we shall require from the beginning funds to pay the salary of an Assistant Secretary and the expenses of an office, and for purposes of publication. We are hoping that in view of the All-India status of our National Institute, and now that concord has been established with the existing Academies, the Government of India will be prepared to contribute a suitable sum annually towards the fulfilment of our regular annual programme. In addition, the National Institute will be prepared to administer funds entrusted to it for particular scientific researches and investigations. Further we hope that wealthy men in India who have the cause of Science at heart will think it suitable to make donations towards the funds of the Institute.

Draft rules are being prepared to provide for the above objectives. Although the objects of the National Institute are thus national and co-operative in type, it is proposed to constitute its Council by direct election by the Fellows from amongst themselves. But to provide for co-operative relationship with the Academies, it is proposed to offer one additional Vice-Presidency and one additional Membership of Council to each Academy to be elected by the Academy from amongst its members, who are Fellows of the National Institute. It is proposed that all elections to the Council shall be conducted by postal ballot.

There is, of course, no intention that the existence of our Fellows should prevent Academies from continuing their own Fellowships where such exist, or to start their own scheme of Fellowships if they think desirable. There is, in fact, as will appear from this note, no intention or desire on the part of the National Institute to interfere with the activities or internal organization of the Academies.

With reference to the revised title, in which the word 'Institute' has been substituted for the word 'Academy', it has its analogy in the *Institut de France*, to which are related five Academies, including *Academie des Inscriptions et Belles-Lettres*, and *L'Academie des Sciences*.

There is, however, a fundamental difference, namely that the French Academies are all branches of the Institute of France. In our case no such subordination or affiliation is proposed. The relationship of the Science Academies in India to the National Institute will be one of co-operation of independent bodies. There is further this difference that whereas the Institute of France is in relationship with Academies for various branches of knowledge, our National Institute is for the purposes of co-ordinating and co-operating only with the scientific activities of Academies.

This change of title necessitated discussion in the Academy Committee whether our terms of reference from the Indian Science Congress, which were to found an Academy of Sciences, would permit us to take this line. It was, however, decided that the instructions of the Indian Science Congress referred rather to the general problem and did not really impose on us any particular title, and that provided the organization we propose to form carries out the objects which the instructions of the Indian Science Congress placed before us, there can be no objection to the proposed change of name.

With reference to the location of the National Institute, if a scheme of co-operation had not been devised, it might have been better to avoid locating the Institute anywhere in order to prevent any form of jealousy.

This might have been arranged by means of a scheme in accordance with which the headquarters moved periodically, say every two years, from one headquarters to another. Such proposals for a peripatetic Institute would, however, have prevented the full development of the Institute and would have been contrary to the dictates of business which require that the Institute must have an office somewhere. The Committee propose to leave the choice of the headquarters to the vote of the Foundation Fellows.

As regards procedure, although the Academy Committee propose in accordance with their mandate to take all steps necessary to found this National Institute, they also propose, in accordance with the pledge given at the meeting of the General Committee of the Indian Science Congress held in Bombay in January, 1934, to defer the final step of actual registration until the formal ratification by the General Committee of the Indian Science Congress Association to be held in Calcutta in January, 1935. It is proposed also to hold the inaugural meeting of the National Institute during or close to the same meeting of the Indian Science Congress Association.

APPENDIX II.

NAMES OF PROPOSED FOUNDATION FELLOWS OF THE NATIONAL INSTITUTE OF SCIENCES OF INDIA.

1. ACTON, Lt.-Col. H. W., C.I.E., M.R.C.S., L.R.C.P., F.A.S.B., I.M.S., Professor of Tropical Medicine, and Director, School of Tropical Medicine, Calcutta.
2. AGHARKAR, S. P., M.A., Ph.D., F.L.S., Ghose Professor of Botany, Calcutta University, Calcutta.
3. AHMAD, NAZIR, M.Sc., Ph.D., Director, Indian Central Cotton Committee's Technological Laboratory, Matunga, Bombay.
4. AJREKAR, S. L., B.A. (Bombay and Cantab.), I.E.S., Professor of Botany, Gujarat College, Ahmedabad.
5. ANANDARAO, K., M.A., I.E.S., Professor of Mathematics, Presidency College, Madras.
6. ASH, W. C., B.Sc., M.I.C.E., A.M.I.Mech.E., Engineer-in-Chief, Harbour Construction, Vizagapatam.
7. AWATI, P. R., B.A., D.I.C., I.E.S., Professor of Zoology, Royal Institute of Science, Mayo Road, Bombay 1.
8. AYYANGAR, G. N. Rangaswami, B.A., I.A.S., Millets Specialist, Agricultural Research Institute, P.O. Lawley Road, Coimbatore, S.I.
9. BAHL, K. N., D.Sc., D.Phil., Professor of Zoology, Lucknow University, Lucknow.
10. BANERJI, S. K., D.Sc., Meteorologist, Meteorological Office, Poona 5.
11. BEESON, C. F. C., D.Sc., Forest Entomologist, Imperial Institute of Forest Research, Dehra Dun, U.P.
12. BERKELEY-HILL, Lt.-Col. O. A. R., I.M.S., Medical Superintendent, European Hospital for Mental Diseases (Retired), Radium Institute, Ranchi.
13. BHASKARA SHASTRI, T. P., M.A., F.R.A.S., Director, Nizamia Observatory, Hyderabad (Deccan).
14. BHATNAGAR, S. S., D.Sc., University Professor of Chemistry, and Director, University Chemical Laboratories, Lahore.
15. BHATTACHARYA, D. R., M.Sc., Ph.D., Dr. ès Sciences (Paris), Professor of Zoology, Allahabad University, 7, Malaviya Road, Allahabad.
16. BOSE, D. M., M.A., B.Sc., Ph.D., Ghose Professor of Physics, Calcutta University, Calcutta.
17. BOSE, G. S., D.Sc., M.B., Head of the Department of Experimental Psychology, Calcutta University, 92, Upper Circular Road, Calcutta.
18. BOSE, Sir J. C., Kt., C.S.I., C.I.E., M.A., D.Sc., F.A.S.B., F.R.S., Director, Bose Research Institute, 93, Upper Circular Road, Calcutta.
19. BOSE, S. N., D.Sc., Professor of Physics, Dacca University, Dacca.
20. BRAHMACHARI, Rai Bahadur, Sir U. N., Kt., M.A., M.D., Ph.D., F.A.S.B., K.I.H., Physician, Medical College Hospitals, Calcutta (Retired), 82/3, Cornwallis Street, Calcutta.
21. BURRIDGE, W., Professor of Physiology, Lucknow University, Lucknow.
22. BURT, B. C., C.I.E., M.B.E., B.Sc., I.A.S., Agricultural Expert, Imperial Council of Agricultural Research, New Delhi.
23. CALDER, C. C., B.Sc. (Agr.), F.L.S., Director, Botanical Survey of India, and Superintendent, Royal Botanic Gardens, Sibpur, Howrah.
24. CHAMPION, H. G., M.A., Sylviculturist, Imperial Forest Research Institute, Dehra Dun.
25. CHAUDHURI, Haraprasad, M.Sc., Ph.D., D.I.C., Reader in Botany, Punjab University, Lahore.

26. CHOWLA, S. D., M.A., Ph.D., Reader in Mathematics, Andhra University, Waltair.
27. CHOPRA, Lt.-Col. R. N., C.I.E., M.B., I.M.S., Professor of Pharmacology, School of Tropical Medicine, Calcutta.
28. COUCHMAN, Brigadier H. J., D.S.O., M.C., Surveyor-General of India, Calcutta.
29. DAS, Sir Kedar Nath, Kt., M.D., F.C.O.G., F.S.M.F., Principal, Carmichael Medical College, Belgachia, Calcutta.
30. DASTUR, R. H., M.Sc., Professor of Botany, Royal Institute of Science, Mayo Road, Bombay 1.
31. DEY, B. B., D.Sc., F.I.C., I.E.S., Professor of Chemistry, Presidency College, Madras.
32. DHAR, N. R., D.Sc., I.E.S., University Professor of Chemistry, Allahabad.
33. DUNNICLIFF, H. B., M.A., Sc.D., F.I.C., I.E.S., University Professor of Inorganic Chemistry, Government College, Lahore.
34. EKAMBARAM, T., M.A., Ph.D., Professor of Botany, Presidency College, Madras.
35. EVANS, P., B.A., F.G.S., Geologist, The Burma Oil Company, Ltd., P.O. Badarpurghat, Dist. Sylhet, Assam.
36. FERMOR, L. L., O.B.E., D.Sc., A.R.S.M., M.Inst.M.M., F.G.S., F.A.S.B., F.R.S., Director, Geological Survey of India, Calcutta.
37. FORSTER, Sir M. O., Kt., D.Sc., Ph.D., F.R.S., Old Banni Mantap, Mysore City.
38. FOWLER, Gilbert J., D.Sc., F.I.C., Consulting Chemist, Central Hotel, Bangalore.
39. FOX, C. S., D.Sc., M.I.Min.E., Superintendent, Geological Survey of India, Calcutta.
40. GHOSH, J. C., D.Sc., University Professor and Head of the Department of Chemistry, Dacca University, Dacca.
41. GHOSH, P. N., M.A., Ph.D., Sc.D. (Hon.), F.Inst.P., Ghosh Professor of Applied Physics, Calcutta University, 92, Upper Circular Road, Calcutta.
42. GLENNIE, Major E. A., D.S.O., R.E., Survey of India, Dehra Dun.
43. GRAVELY, F. H., D.Sc., F.A.S.B., Superintendent, Government Museum, Museum House, Egmore, Madras.
44. GUHA, B. S., M.A., Ph.D., Assistant Superintendent, Zoological Survey of India, Indian Museum, Calcutta.
45. HADDOW, J. R., B.Sc., M.R.C.V.S., D.V.S.M., Veterinary Research Officer in charge of Serology, Imperial Veterinary Research Institute, Muktesar, U.P.
46. HANUMANTHA RAO, C. V., M.A., University Professor of Mathematics, Punjab University, Lahore.
47. HERON, A. M., D.Sc., F.G.S., F.R.G.S., F.R.S.E., Superintendent, Geological Survey of India, Calcutta.
48. HORA, S. L., D.Sc., F.R.S.E., F.L.S., F.Z.S., F.A.S.B., Superintendent, Zoological Survey of India, Indian Museum, Calcutta.
49. HUSSAIN, M. Afzal, M.A., M.Sc., I.A.S., Principal, Punjab Agricultural College, Lyallpur, Punjab.
50. HUTTON, J. H., C.I.E., M.A., D.Sc., F.A.S.B., I.C.S., Deputy Commissioner, Naga Hills, Kohima, Assam.
51. IYENGAR, M. O. P., M.A., Ph.D., F.L.S., University Professor of Botany, Madras.
52. IYER, L. K. Ananthakrishna, B.A., L.T., Officer-in-charge of Ethnographic Survey, Mysore, Lakshminarayanapuram, Palghat, P.O. Kulpathi.
53. JARDINE, A., D.Sc., M.Inst.C.E., Jessop and Co., Calcutta.
54. KAPUR, S. N., D.Sc., Imperial Forest Research Institute, Dehra Dun.
55. KASHYAP, S. R., Rai Bahadur, B.A., M.Sc., D.Sc., I.E.S., F.A.S.B., Professor of Botany, Government College, Lahore. (Since deceased.)

56. KING, C. A., B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.M., M.I.E. (Ind.), Principal, Engineering College, Benares Hindu University, Benares.
57. KNOWLES, Lt.-Col. R., B.A., M.R.C.S., L.R.C.P., F.A.S.B., I.M.S., Professor of Protozoology, School of Tropical Medicine, Calcutta.
58. KOSHY, P. K., F.R.C.P., Professor of Anatomy, Medical College, Madras.
59. KRISHNA, S., Ph.D., D.Sc., F.I.C., Forest Biochemist, Imperial Forest Research Institute, Dehra Dun (U.P.).
60. KRISHNAMURTI, V., G.M.V.C., I.V.S., Professor of Pathology and Bacteriology, Madras Veterinary College, Veda Vilas, Vellala Street, Vepery, Madras. (Since deceased.)
61. KRISHNAN, K. S., D.Sc., Mahendra Lal Sircar Professor of Physics, Indian Association for the Cultivation of Science, 210, Bow Bazar Street, Calcutta.
62. KRISHNAN, K. V. A., M.B.B.S., L.R.C.P., D.B., Bacteriological Research Officer, School of Tropical Medicine, Calcutta.
63. MAHAJANI, G. S., M.A., Ph.D., Principal and Professor of Mathematics, Fergusson College, Poona 4.
64. MAHALANOBIS, P. C., M.A., B.Sc., I.E.S., Professor of Physics, Presidency College, Calcutta.
65. MATHUR, K. K., B.Sc. (Hons.) (Lond.), A.R.S.M., University Professor of Geology, Hindu University, Benares.
66. MATTHAI, George, M.A., Sc.D., F.L.S., F.Z.S., F.R.S.E., Professor of Zoology, Government College, Lahore.
67. MCCARRISON, Maj.-Gen. Sir R., Kt., C.I.E., M.D., D.Sc., F.R.C.P., LL.D., I.M.S., Director of Nutritional Research, Coonoor.
68. MCMAHON, P. S., M.Sc., B.Sc. (Oxon), F.I.C., I.E.S., Professor of Chemistry, Lucknow University, Lucknow.
69. MEHTA, K. C., M.Sc., Ph.D., Professor of Botany, Agra College, Agra.
70. METCALFE, E. P., D.Sc., F.Inst.P., Vice-Chancellor, Mysore University, Bangalore.
71. MITRA, S. K., D.Sc., Khaira Professor of Physics, Calcutta University, 92, Upper Circular Road, Calcutta.
72. MITTER, P. C., M.A., Ph.D., Ghosh Professor of Chemistry, Calcutta University, 92, Upper Circular Road, Calcutta.
73. MOHAMMED, Wali, M.A., Ph.D., I.E.S., University Professor of Physics, Lucknow University, Lucknow.
74. MOOKERJEE, Sir R. N., K.C.I.E., K.C.V.O., Hon. M.I.M.E., M.I.E. (Ind.), Hon. F.A.S.B., Hon. D.Sc. (Cal.), Senior Partner, Martin & Co., and Burn & Co., 12, Mission Row, Calcutta.
75. MOWDAWALLA, F. N., M.A., M.I.E.E., Mem.A.I.E.E., M.I.E., Principal and Professor of Electrical Engineering, University College of Engineering, Bangalore.
76. MUKERJI, Syamadas, M.A., Ph.D., 3, Palit Street, Ballygunj, Calcutta.
77. MUKHERJI, J. N., D.Sc., Khaira Professor of Chemistry, Calcutta University, 92, Upper Circular Road, Calcutta.
78. NAIK, K. G., D.Sc., Professor of Chemistry, Baroda College, Baroda.
79. NARAYAN, A. L., M.A., D.Sc., Solar Physics Observatory, Kodaikanal.
80. NORMAND, C. W. B., M.A., D.Sc., Director-General of Observatories, Meteorological Office, Poona 5.
81. OLVER, Col. A., C.B., C.M.G., F.R.C.V.S., Animal Husbandry Expert, Imperial Council of Agricultural Research, New Delhi.
82. PARIJA, P. K., M.A., B.Sc., I.E.S., Professor of Botany, Ravenshaw College, Cuttack.
83. PENMAN, D., D.Sc., F.R.S.E., Chief Inspector of Mines in India, Dhanbad.
84. PHILPOTT, H. P., Professor of Engineering, Hindu University, Benares.

85. PINFOLD, E. S., M.A., F.G.S., Geologist, The Attock Oil Co., Ltd., Rawalpindi.
86. PRASAD, Ganesh, M.A., D.Sc., Hardinge Professor of Higher Mathematics, Calcutta University; 2, Samavaya Mansions, Calcutta.
87. PRASHAD, Baini, D.Sc., F.R.S.E., F.L.S., F.Z.S., F.A.S.B., Director, Zoological Survey of India, Indian Museum, Calcutta.
88. PRUTHI, H. S., M.Sc., Ph.D., Imperial Entomologist, Imperial Institute of Agricultural Research, Pusa-Delhi.
89. QUREISHI, Muzaffaruddin, Ph.D., Professor of Chemistry, Osmania University, Hyderabad (Deccan).
90. RAMAN, Sir C. V., Kt., M.A., D.Sc., Ph.D., LL.D., F.R.S., F.A.S.B., N.L., Director, Indian Institute of Science, Bangalore.
91. RAMANATHAN, K. R., M.A., D.Sc., Meteorologist, Weather Office, Poona 5.
92. RAO, C. R. Narayana, M.A., Professor of Zoology, Central College, Bangalore.
93. RAY, Sir P. C., Kt., M.A., Ph.D., D.Sc., F.A.S.B., Palit Professor of Chemistry, Calcutta University, Calcutta.
94. RAY, P. R., M.A., Lecturer in Chemistry, Calcutta University, 92, Upper Circular Road, Calcutta.
95. ROW, R., M.D., D.Sc., Lt.-Col. (Hon.), I.M.S., New Marine Lines, Bombay 1.
96. ROYDS, T., D.Sc., Director, Solar Physics Observatory, Kodaikanal.
97. SAHA, M. N., D.Sc., F.R.S., F.A.S.B., University Professor of Physics, Allahabad University, Allahabad.
98. SAHNI, B., M.A., Sc.D., D.Sc., F.G.S., F.A.S.B., University Professor of Botany, Lucknow University, Lucknow.
99. SAMPAT IYENGAR, P., M.A., formerly Director, Mysore Geological Department, Bangalore. (Since deceased.)
100. SEN, B. M., M.A., M.Sc., I.E.S., Principal, Presidency College, Calcutta.
101. SEN, H. K., M.A., D.Sc., D.I.C., Ghose Professor of Applied Chemistry, Calcutta University, 92, Upper Circular Road, Calcutta.
102. SEN, N. R., D.Sc., Ghose Professor of Applied Mathematics, Calcutta University, 92, Upper Circular Road, Calcutta.
103. SHAW, F. J. F., D.Sc., A.R.C.S., F.L.S., Imperial Economic Botanist, Director, Imperial Institute of Agricultural Research, Pusa (Bihar).
104. SINGH, B. K., M.A., Sc.D., F.I.C., I.E.S., Professor of Chemistry, Ravenshaw College, Cuttack.
105. SINTON, V. C., Lt.-Col., I.M.S., Director, Malaria Survey of India, Kasauli (Simla Hills).
106. SOKHEY, Lt.-Col. S. S., M.A., D.Sc., M.D., D.T.M. & H., I.M.S., Director, Haffkine Institute, Parel, Bombay.
107. SPRAWSON, Maj.-Gen. C. A., C.I.E., F.R.C.P., K.H.P., I.M.S., Director-General, Indian Medical Service, New Delhi.
108. STEWART, Lt.-Col. A. D., C.I.E., M.B., D.P.H., D.T.M. & H., F.R.C.S.E., I.M.S., Director, All-India Institute of Hygiene and Public Health, 21, Chittaranjan Avenue, Calcutta.
109. SUBRAMANYAM, V., D.Sc., F.I.C., Department of Biochemistry, Indian Institute of Science, Bangalore.
110. TAYLOR, Lt.-Col. J. B., D.S.O., M.D., D.P.H., I.M.S., Director, Central Research Institute, Kasauli (Simla Hills).
111. TRUMURTI, T. S., R.B., B.A., M.B. & C.M., D.T.M. & H., Professor of Pathology, Medical College, Vizagapatam.
112. TREVOR, C. G., C.I.E., President, Imperial Forest Research Institute, Dehra Dun.
113. VAIDYANATHASWAMY, R., M.A., Ph.D., D.Sc., Reader in Mathematics, Madras University, Madras.
114. VENKATARAMAN, T. S., Rao Bahadur, M.A., Imperial Sugar Cane Specialist, P.O. Lawley Road, Coimbatore.

115. VENKATESACHAR, B., Rao Bahadur, M.A., Professor of Physics, Central College, Bangalore.
116. VIJAYARAGHAVACHARYA, Sir T., Diwan Bahadur, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research, Secretariat, New Delhi.
117. VIJAYARAGHAVAN, T., Ph.D. (Oxon), Reader in Mathematics, Dacca University, Ramna, Dacca.
118. VISHWANATH, B., R.B., F.I.C., Imperial Agricultural Chemist, Imperial Agricultural Research Institute, Pusa-Delhi.
119. VISWESWARAYA, Sir M., K.C.I.E., M.Inst.C.E., LL.D., D.Sc., Uplands, High Ground, Bangalore.
120. WARE, F., F.R.C.V.S., I.V.S., Director, Imperial Institute of Veterinary Research, Muktesar (U.P.).
121. WARTH, F. J., D.Sc., I.A.S., Imperial Dairy Research Institute, Bangalore.
122. WADIA, D. N., M.A., B.Sc., F.G.S., F.R.G.S., F.A.S.B., Assistant Superintendent, Geological Survey of India, Calcutta.
123. WEST, W. D., M.A. (Cantab.), Assistant Superintendent, Geological Survey of India, Calcutta.
124. WHEELER, T. S., F.I.C., Ph.D., F.R.C.S.I., Principal, Royal Institute of Science, Mayo Road, Fort, Bombay 1.
125. WRAIGHT, E. A., A.R.S.M., M.I.M.M., F.I.C., Metallurgical Inspector, Jamshedpur (B. & O.).

APPENDIX III.

(A) CONSTITUTION ADOPTED AT THE MEETING OF THE INDIAN ACADEMY OF SCIENCES, ON 31ST JULY, 1934, AT BANGALORE.

(B) CHANGES WHICH SIR C. V. RAMAN, PROF. B. VENKATESACHAR, AND PROF. C. R. NARAYAN RAO AGREED TO RECOMMEND TO THE COUNCIL OF THE INDIAN ACADEMY OF SCIENCES, BANGALORE.

THE INDIAN ACADEMY OF SCIENCES.

A. MEMORANDUM OF ASSOCIATION.

I. The name of the Association shall be 'The Indian Academy of Sciences' which name shall be changed to 'The Royal Society of India' on receipt of Royal Charter.

II. The objects of the Academy are :—

1. To promote the progress and uphold the cause of science, both in pure and applied branches.
2. To co-operate with the existing Provincial Academies having similar objects, and with others when founded.
3. To encourage and publish important researches in the branches of science comprehended by the Academy and to represent internationally the scientific work of India.
4. To undertake, control and direct scientific enterprises of All-India significance and to participate in similar international activities.
5. To collect, sort out and disseminate information concerning the industrial, economic, and labour problems relating to India and other progressive countries.
6. To publish books, memoirs, journals, proceedings, and transactions relating to scientific researches in pure

I. The name of the Association shall be 'The Indian Academy of Sciences' which name shall be suitably changed on receipt of Royal Charter.

II. The objects of the Academy are :—

1. To promote the progress and uphold the cause of science, both in pure and applied branches.
2. To co-operate with the existing scientific organizations in India and others that may be founded hereafter on matters of common interest.
3. To encourage and publish important researches in the branches of science comprehended by the Academy, and to be represented in the international Congresses and Conferences, and the like.
4. To undertake, control and direct scientific enterprises in India and to participate in international scientific activities.
5. To collect, sort out and disseminate information concerning the industrial, economic, and labour problems relating to India and other progressive countries.
6. To publish books, memoirs and journals, proceedings and transactions relating to scientific researches in

and applied branches initiated by the Academy and those conducted under the direction of Provincial Academies, the Universities, and Government Scientific Institutions.

7. To organize and arrange for the meetings of Congress, Committees, and Conferences for reading and discussing papers submitted to the Academy, advising Government and other bodies on scientific and other matters referred to the Academy and to co-operate with the National Research Council when instituted.
8. To secure and administer funds, grants, and endowments for the furtherance of scientific research.
9. To undertake and execute all other acts which shall assist in and promote the usefulness, aims and purposes of the Academy.

III. The Academy shall not make any profit nor award bonus to any of its members but may pay remuneration to the members of its permanent staff. In addition, it may make awards of prizes and research grants to individuals and organizations for the advancement of scientific knowledge.

pure and applied branches initiated by the Academy and those conducted under the direction of other institutions including Universities and Government Scientific Laboratories.

7. To organize and arrange for the meetings for reading and discussing papers submitted to the Academy, advising Government and other bodies on scientific and other matters referred to the Academy and to co-operate with the National Research Council, when instituted, in all matters of national importance.
8. No change.
9. No change.

III. No change.

B. CONSTITUTION.

I. Membership.

The Academy shall consist only of Fellows.

The Academy in the first instance shall consist of Fellows: The question of taking other classes of members shall be taken up as the necessity arises.

At a meeting of the Executive Committee of the Twenty-second Congress, held on the 2nd January, 1935, it was resolved to recommend the above Report to the General Committee for adoption.

At a special meeting of the General Committee of the Twenty-second Congress, held on the 3rd January, 1935, Dr. L. L. Fermor presented the report on behalf of the Academy Committee and proposed its adoption. After considerable discussion in which several members took part, the following resolutions were passed unanimously :—

'Resolved that the General Committee of the Indian Science Congress Association adopt the scheme for the foundation of a National Institute of Sciences of India, as formulated in the report of the Academy Committee.'

'Resolved further that a recommendation be made to the Council of the National Institute of Sciences of India to elect in the first year 25 Ordinary Fellows plus the vacancies in the initial 125 Foundation Fellows instead of 10 Ordinary Fellows plus the vacancies, as laid down in rule 7 of the provisional rules of the National Institute.'

INAUGURATION OF THE NATIONAL INSTITUTE OF
SCIENCES OF INDIA.

The Inaugural Meeting of the National Institute of Sciences of India was held in the Senate Hall of the University of Calcutta on the 7th January, 1935. Dr. J. H. Hutton, President of the Indian Science Congress Association, was in the chair, supported by Dr. L. L. Fermor, President of the National Institute of Sciences of India, and the meeting was honoured by His Excellency Sir John Anderson, Governor of Bengal, who was present for the purpose of inaugurating the National Institute. His Excellency inaugurated the Institute and delivered an address. Thereafter Dr. L. L. Fermor delivered his Presidential Address.

ACCOUNTS.

I.

Account of the Indian Science Congress for the year ending the 31st December, 1934.

RECEIPTS.			EXPENDITURE.		
	Rs.	A. P.		Rs.	A. P.
To Balance ...	19,351	12 11	By Indexing ...	176	0 0
„ Interest on Fixed Deposits ...	255	11 0	„ Bonus ...	600	0 0
„ Subscription received from Local Secretary, Bombay ...	2,267	0 0	„ Contingencies ...	35	0 3
„ Local Secretary's contribution (Bombay) ...	408	0 0	„ Donation to 'Current Science' ...	250	0 0
„ Subscriptions from Permanent Members ...	4,511	10 0	„ Printing ...	8,228	1 0
„ Advances :—			„ Advances :—		
H.E. The Governor of Bengal, for local expenses ...	500	0 0	Dr. S. K. Mitra for local expenses ...	500	0 0
„ Lt.-Col. Owen B. Hill towards admission fee and annual subscription of National Institute of Sciences of India ...	68	0 0	„ Dr. S. P. Agharkar for Misc. expenses re Calcutta Session of the Congress ...	100	0 0
„ Subscriptions ...	2,106	12 0	„ Postage ...	663	6 6
TOTAL ...	29,468	13 11	„ Balance (in Bank) ...	3,916	6 2
			„ Fixed Deposit ...	15,000	0 0
			TOTAL ...	29,468	13 11

S. L. HORA,
*Honorary Treasurer,**
Asiatic Society of Bengal.

II.

INDIAN SCIENCE CONGRESS, CALCUTTA, 1935.

Statement of Accounts of the Local Reception Committee.

RECEIPTS.			EXPENDITURE.		
	Rs.	A. P.		Rs.	A. P.
To Donation :—			By Opening ceremony		
H.E. Governor of Bengal ...	500	0 0	and Meetings ...	2,465	12 0
Government of Bengal ...	2,500	0 0	Guide-Book ...	2,296	15 0
University of Calcutta ...	3,000	0 0	„ Excursion :—		
Other Donations ...	5,036	0 0	Outside ...	1,257	6 9
„ Excursion :—			Local ...	172	0 0
Tickets sold for out-side Excursion ...	877	0 0	Public Dinner ...	1,150	3 0
Tickets sold for Local Excursion ...	99	8 0	University Party ...	1,017	0 0
„ Guide-Book :—			Steamer Party ...	856	0 0
Receipts from Advertisement ...	940	0 0	Volunteers' Expenses ...	909	3 3
Receipts from sale of Books ...	37	8 0	Residence ...	492	5 9
Stall Rent from Exhibitors ...	622	0 0	Printing ...	738	1 0
Residence ...	246	4 0	Establishment ...	385	3 0
Public Dinner ...	110	0 0	Conveyance ...	255	12 6
Sale Proceeds of Articles ...	68	8 3	Cost of Photographs ...	223	8 0
Membership Fee ...	42	0 0	Postage and Telegram ...	248	12 6
Bank Interest ...	12	15 9	Stationery ...	82	0 3
			Musical Soiree ...	75	0 0
			Audit Fee ...	50	0 0
			Typing Charges ...	44	0 6
			Telephone ...	23	8 0
			Membership Fee (Indian Science Congress Association) ...	42	0 0
			Bank Charges ...	3	0 0
			„ Cash Balance :—		
			At Bank ...	*1,252	13 6
			With Treasurer ...	*51	3 0
TOTAL ...	14,091	12 0	TOTAL ...	14,091	12 0

SATISH CHANDRA GHOSH,
Hony. Treasurer.

B. M. SEN,
S. K. MITRA,
Hony. Local Secretaries.

I have audited the above Statement of Receipts and Payments of the Local Reception Committee, Indian Science Congress Association with the books and vouchers, and have obtained all the information and explanations I have required and I certify the same as correct.

10, Old Post Office Street,
Calcutta, the 6th September, 1935.

A. K. GHOSH,
Govt. Diplomaed Accountant } Auditor.
Registered Accountant.

* At a meeting of the Local Reception Committee, held on Saturday, the 21st September, 1935, in the room of the Vice-Chancellor of the University of Calcutta, it was resolved that the balance Rs. 1,304-0-6 be made over to the Funds of the National Institute of Sciences of India which was inaugurated under the auspices of the 22nd Session of the Indian Science Congress Association. The Committee desire that the sum should be invested in some suitable security and only its interest utilized for the purposes for which the Institute was founded.

I. A. R. I. 75-

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